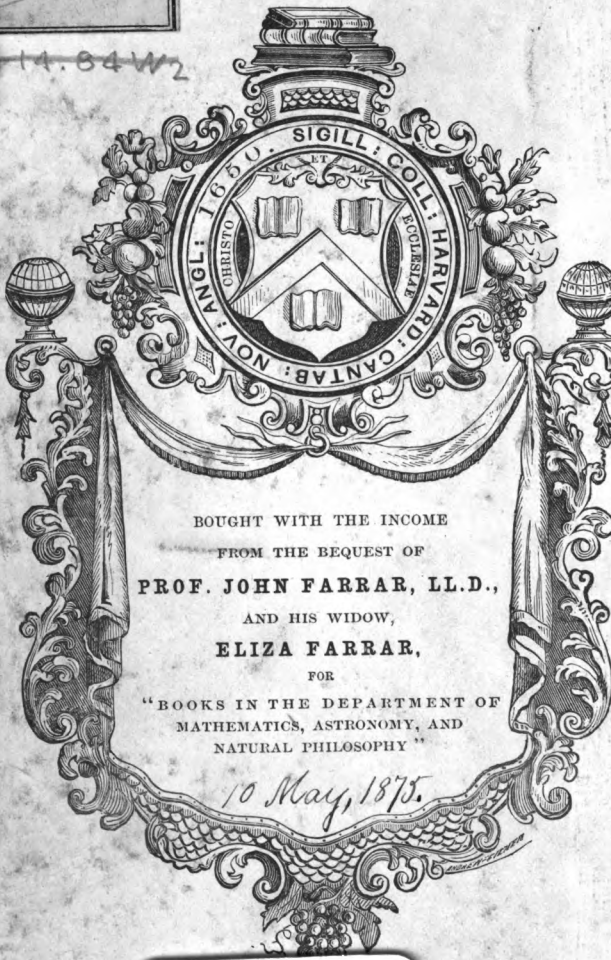

A POPULAR DESCRIPTION OF

THE HUMAN EYE,

WITH REMARKS ON

THE EYES OF INFERIOR ANIMALS.

BY

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WITH FORTY ILLUSTRATIONS.

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PREFACE.

THE chief portion of this little book has frequently been given by the author in the form of a lecture. The material facts it contains have been collected and arranged as carefully as the very limited leisure and irregular opportunities of a medical practitioner would permit. It has been the author's aim to give, in as concise a form as possible, an intelligible exposition of the wondrous power, variety, and perfection of the organ of vision in the various orders of creation; and if he has been so far successful as to excite a desire in others to study the subject for themselves, his task will be fully achieved, and his labour amply repaid. In one or two instances the author has been tempted to digress somewhat from the strict line he had originally prescribed to himself; but the nature of those digressions is not, he hopes, out of keeping with the rest of the work, nor

wanting in interest and instruction. Most of the illustrations have been copied from the works of other authors, an acknowledgment of whose names will be found on pages ix. and x.

W. WHALLEY.

Bradford,
Yorkshire, 1874.

CONTENTS.

CHAPTER I.

	PAGE.
The Analogies and Distinctions of the Eye	1
Structure of the Sclerotic Coat	3

ERRATA.

Page 4, for *form*, read *forms*.
,, 30, for *bibitorious*, read *bibitorius*.
,, 103, for *Cyclops*, read *Cyclopes*.

... ...	10
Diversities of Colour in the Eye	15
M. Georges Pouchet on the Changes of Colour in Fishes and Crustacea	16
Variations in the Shape of the Pupil	17
Voluntary Power Exercised by the Iris in some Birds...	19
The Iris in some Fishes not Possessed of Contractile Power	19
Structure of the Human Retina	19
Milton's Blindness	21
Humours of the Eye	24
Aqueous Humour	24

PAGE.

Crystalline Humour and its Changes at Different Periods of Life 26
Long and Short Sight 27
Form of the Crystalline Lens in Birds, Reptiles, and Fishes 28
Vitreous Humour 28
Muscles of the Eyeball 29
A Seventh Muscle attached to the Eyeball in Quadrupeds 31
Lachrymal Gland and Ducts 32
Tears and their Function 33
Orbital Cavity 35
The Gorilla 36
Roof of the Orbit 41
The Eyelids in Man 41
Conjunctiva 42
Meibomian Glands and Ducts 42
Muscles of the Eyelids 43
The Eyelids in Birds, Beasts, Fishes, and Reptiles ... 44
Peculiarities in the Opening of the Eyelids in different Creatures... 46
Varieties in the Eyebrows 47
„ „ Eyelashes 48

CHAPTER II.

Structural Characteristics of the Eye 50
The Size of the Eye Compared with the Weight and Bulk of various Animals 50
The Eye in Extinct Saurians 51
Animals Possessing the most Acute Vision 52
Eye of a Bird 52
Colour of the Eyes of Birds 55
Colour of the Eyelids of Birds 57
Mechanism of the Organs of Vision in Birds 57

PAGE.

Dr. R. J. Lee's Researches on the Organ of Vision in Birds... 58
The Faculty of Sight in the Hawk and South American Condor 59
The Nictitating or Winking Membrane and its Function in Birds 60
The Umbrella Bird 62
The Haw in Quadrupeds... 63
Structure of the Eye of a Fish 65
Structure of the Crystalline Lens in Fishes 67
Muscles of the Eyeball in Fishes 68
The Eyes of Fish, Man, and Bird Compared 68
Eyes of Amphibious Animals... 69
Sight of the Whale 69
Dugong 69
Eel and Mud-Crab 70
Crayfish and Anableps, or Four-Eyed Fish 71
Eyes of Cuttle-Fish 72
Acephala and Gasteropoda 73
The Medusa, Thorny Oysters, Scallops, Star-Fish, Annelida, and Argonauta 74
The Nautili, Periwinkles, Auger-Shells, the Genus Nassa, Strombs, Infusoria... 75
Zoophytes 75
Eyes of Insects 76
Structure and Situation of Simple and Compound Eyes 76
Number of Eyelets in some Compound Eyes 79
Shape of the Eyes of Insects... 80
Colour of the Eyes of Insects 81
The Position of the Organs of Vision in the Mammalia 83
,, ,, Eyes of the Giraffe 84
,, ,, ,, Horse, Dog, Wolf, and Fox 85
The Position of the Eyes of Bats 86

PAGE.

The Position of the Eyes of the Mole 87
Dr. R. J. Lee's Investigations on the Eye of the Mole 88
Babyroussa, or Indian Hog 89
Ornithorhynchus Paradoxus, or Duck-Billed Platypus ... 90
The Position of the Eyes in Birds and Serpents ... 93
The Chameleon 94
Animals which are Endowed with the Singular Property of Moving their Eyes Independently of each other ... 96
Animals which Possess the Faculty of Changing their Colour 97
The Wisdom Displayed in the Diversity of Colour in different Animals 98
The Position of the Eyes in Fishes 99
" " the Angler, Whale, and Star-Gazer 99
The Position of the Eyes in the Shark, Ray, and Flat-Fish 100
" " Insects 101
" " Crustaceans 102
" " Spiders 103
" " Snails 105
" " Worms 106

CHAPTER III.

The Function of Vision 108
The Retention of Visual Sensations in Health and Disease 112
Colour-Blindness 113
Absence of Vision in certain Animals 115
The Development of Sight in Man and the Lower Animals 117

LIST OF ILLUSTRATIONS.

	COPIED FROM.	PAGE.
The Human Eye	*R. Tract Socy.*	3
External View of the Eye of the Snowy Owl	—	5
A Dissection of the Eyeball, showing the Choroid Membrane and the Venæ Vorticosæ	*Wilson* ...	9
The Human Iris	*Paley* ...	14
The Iris of a Lion	*Do.* ...	18
Posterior Segment of a Transverse Section of the Globe of the Eye	*Wilson* ...	23
Longitudinal Section of the Globe of the Eye	*Do.* ...	25
Muscles of the Eyeball	*Do.* ...	31
Lachrymal Gland and Ducts	*R. Tract Socy.*	32
The Gorilla	—	37
Meibomian Glands	*Wilson* ...	42
Muscle of the Eyelids	*R. Tract Socy.*	43
Chinese Lady	—	47
Eye of the Secretary Bird, showing the Nictitating, or Winking Membrane ...	*R. Tract Socy.*	60
Umbrella Bird	*W. Mackenzie*	62
Eye of a Fish	*R. Tract Socy.*	66
Lens of a Fish, with its Fibres	*Do.*	67
Head of the Eel	*Paley* ...	70
Anableps, or Four-Eyed Fish	*W. Mackenzie*	72

	COPIED FROM.	PAGE.
Cuttle-Fish	—	73
Head of the Nereis	*Nunneley* ...	74
Eye-Dots	*Do.*	74
Group of Prismatic Facets from the Eye of a Bee	*R. Tract Socy.*	77
Six-Sided Facets from the Eye of a Cockchafer	*Nunneley* ...	77
Square Facets from the Eye of a Moth...	*Do.*	77
Section of the Eye of the Cockchafer ...	*Do.*	78
Eye of a Beetle	*Do.*	80
Eyes of the Giraffe	*R. Tract Socy.*	84
Ornithorhynchus Paradoxus	—	91
The Chameleon	*R. Tract Socy.*	95
Flat-Fish	—	100
Eye of the Scorpion	*Nunneley* ...	101
Eye of the Common Millepede	*Do.* ..	102
Eye of the Caterpillar	*Do.* ...	102
Eye of the Shrimp	*Do.* ...	103
Spider's Head	*Do.* ...	104
Helix Aspersa, Common Garden Snail ...	*Paley* ...	105
Head of the Leech	*Nunneley* ...	106
Figure of the Eye, showing the Formation of an Image on the Retina ...	—	109
Figure Representing a Lens placed in an Opening in a Window Shutter, &c. ...	*R. Tract Socy.*	110

CHAPTER I.

THE STRUCTURAL ANALOGIES AND DISTINCTIONS OF THE HUMAN EYE, COMPARED WITH THOSE OF ANIMALS.

THE skill manifested in the mechanism of the human eye has not only engaged the special attention of anatomists, but philosophers, poets and divines in all ages have been fascinated by the marvels that distinguish this organ. From past records we learn that the eye has been honoured by a more general study than any other organ of the senses. It has been designated "the queen of the senses," "the index of the mind," "the window of the soul;" nay, it has even been esteemed "in itself a soul;" and "He who spake as never man spake" has declared that "the light of the body is the eye," at which we cannot marvel when we contemplate the inestimable pleasures and advantages it confers upon mankind. Were it not for this grand

attribute of man the wonders achieved by the arts and sciences could have no charms for him. Talk to one bereft of this faculty of "the god of day" as he sinks in majesty in the west, forming a circle of gold and purple clouds; of the azure sky; the silvery radiance of the moon and innumerable stars, which enchant the soul of the astronomer; of the majestic ocean, which bears upon its bosom the argosies of many nations; of broad landscapes, watered with crystal streams; of the snow-clad mountain scenery, amidst which the tourist delights to ramble; of the dashing and foaming rivers, whose banks are embroidered with wild flowers of every varied hue;—all these, and a thousand other infinitely varied scenes of grandeur, happiness and wealth may excite his admiration, but are received more as a matter of surprise than pleasure, and pass away like the baseless fabric of a dream.

"Sounds which address the Ear, are lost and die
In one short hour; while that which strikes the Eye
Lives long upon the mind; the faithful sight
Graves on the mem'ry with a beam of light."

Scientific literature has invariably the misfortune of being fettered by a somewhat difficult nomenclature, but we shall dispense with pro-

fessional technicalities as far as practicable, and when such are made use of, it will be our endeavour to explain and simplify, so as to render the subject both comprehensive and acceptable.

The various structures constituting the eye, which we purpose describing briefly, may be readily demonstrated by procuring the eye of a sheep or bullock, and dissecting away the fat and remnants of muscle on its outer covering, care being taken not to remove the fragment of optic nerve, which, like a short thick white cord, will be seen entering at the back of the eyeball.

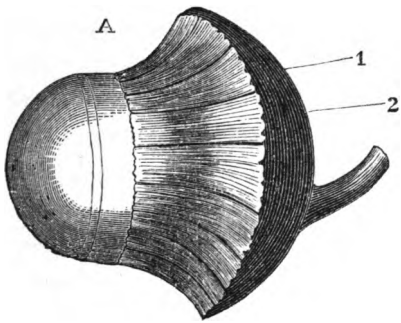
The Human Eye. *aa*, the Sclerotic Coat; *b*, the Cornea.

The globular form of the human eye is mainly due to its first or outer tunic, named the sclerotic. This word is derived from the Greek word *Scleros*, and means hard.

The sclerotic coat is thicker behind than in front, and is the most extensive of any of the coverings of the eyeball, nearly four-fifths of the globe being enclosed in it. It is of a pearly white colour, popularly termed the white of the eye. In front it is open, and receives the transparent cornea; behind it affords transmission to the optic nerve.

The sclerotic membrane consists of bundles of strong, dense, and tenacious white fibres, interwoven in every direction, admirably adapted for effecting the important services which are imposed upon it, namely, that of giving attachment to the muscles by which the eyeball is moved; moreover, it maintains the sphericity of this organ, and defends from injury the delicate structures consigned to its keeping. In certain vertebrate animals, or animals which have internal skeletons and backbones, the sclerotic coat is more or less ossified. In some birds—for example, the common domestic fowl, and the owl—a ring of small bony plates form a complete belt, which has not inappropriately been likened to the framework of a watchmaker's eyeglass. These bony plates not only afford advantageous attachments to

the very curiously arranged muscles that move the nictitating membrane, but appear calculated to preserve the somewhat oval shape of the lenses, and thus obviate that tendency to the form of a globe which fluids on compression naturally assume.



A, External View of the Eye of the Snowy Owl.
1, Imbricated Osseous Plates.
2, Posterior Part of the Sclerotic Coat.

In the chameleon, lizard, crocodile, alligator, and iguana, besides a large class of reptiles, including tortoises, turtles, and the extinct ichthyosaurus, the sclerotic coat is similar to that of birds in being encircled by a girdle of osseous plates, while in the frog and toad it is formed by an inner and an outer layer, the

former cartilaginous, and the latter fibrous. The same arrangement is observed in such fish as the haddock, sole, and halibut. In some quadrupeds the sclerotic coat resembles that of man, in being thicker and firmer behind than in front. In the whale a posterior section measures an inch and a half in thickness, yet the sclerotic coat of the porpoise, whose structure is analogous to that of the whale, is not more than two or three lines thick. In the ray it is fashioned into a pedicle or stalk, to which the eye is attached; in the sword-fish it is transformed into an unyielding cup of bone, and in the sturgeon it is converted into a compact cartilaginous case, while the eye of the lamprey is peculiar in being destitute of this covering.

In the front of the eye there is a clear transparent and nearly circular window (marked *b* in the first figure), which, from its shape, has been very aptly compared to a common watchglass. It forms the anterior fifth of the eyeball, and is called the cornea (Latin from *cornu*, "horn"). It is composed of fibres disposed in five concentric layers united by cellular tissue, and, from its horny and elastic texture, is well qualified, in conjunction with the sclerotic coat,

for protecting the internal structures of the eye, at the same time that it gives passage to the light.

The simple and compound eyes of animals are covered by a common cornea. In the singular eye of the *anableps*, or four-eyed fish, and also in some of the mollusca or shell-fish, the cornea is divided into two portions by an opaque transverse band, and in the cuttle-fish it is absolutely wanting, as is also the aqueous humour.

In many fishes, serpents, and geckoes among lizards, the transparent skin of the head passes over the front of the eye and unites with the conjunctiva, being "set like a spectacle-glass, as it were, in a sort of frame formed by the common skin around the margin of the orbit." In the blind eel, hagfish, blind rat, and golden mole, the eye is veiled by a dense opaque mucous membrane studded with hairs.

The manner of union of the cornea with the sclerotic coat presents a marked diversity in different animals. In man, the ox, and the tope-fish, the circumference of the cornea slides under the anterior edges of the sclerotic

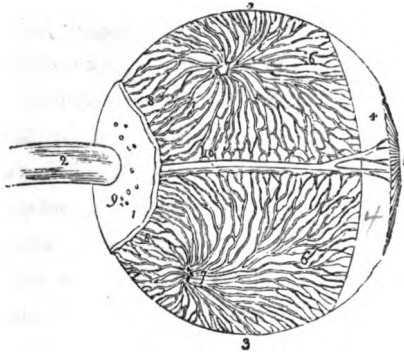
very much in the same way that a watch-glass is fixed in the groove of its case, but they differ from the latter in being inseparably united; their union is well represented in the diagram at page 25. In the hare, the corneal margin is received within the open border of the sclerotic coat, and in the whale and rhinoceros the fibres of the sclerotic coat are distinctly seen piercing the cornea, having the appearance of very fine white lines.

On removing the sclerotic coat we bring into view the second tunic or choroid membrane; it is found in the eyes of all animals, and is thin, vascular, and composed of three layers. The *outer layer* consists chiefly of veins termed the *venæ vorticosæ;* arranged in a whirl-like form, their beauty is well depicted in the accompanying diagram, marked 6, 6.

The *middle layer*, or *Ruyschian membrane*, is mainly composed of minute branches of arteries which present a network appearance.

The *inner layer* is called the *membrana pigmenti*, and may be seen on turning to page 25. It consists of a single layer of minute six-sided cells, whose disposition has been likened to a mosaic or tesselated pavement. The cells

enclose little grains of *pigmentum nigrum*, which has the semblance of black paint; on careful inspection, however, it will be found of a chocolate colour. In some birds it is reddish-brown; in the hare and rabbit, brownish-black, and in the cuttle-fish of a purple-red colour.



The above diagram represents the eyeball divested of its first tunic, so as to exhibit the choroid membrane. At the space marked 1, is a part of the sclerotic coat; 2, the optic nerve entering at the back of the eyeball; 3, 3, indicate the outline of the choroid coat; 4, the ciliary ligament, a dense broad white structure, encircling the circumference of the iris: it not only effects a bond of union between the outer

and middle coverings of the eye, but serves to unite the cornea and sclerotic at their junction with the iris (marked 5) and outer layer of the choroid; 6, 6, mark the venæ vorticosæ; and 7, 7, the trunks of these veins; 8, 8, the posterior ciliary veins, and arteries entering the eyeball through the sclerotic at 9; 10, one of the ciliary nerves and a long ciliary vein.

In many of the mammalia, or animals that suckle their young, the inner surface of the membrane of Ruysch presents a brilliant metallic looking layer called *tapetum lucidum*, which not infrequently exhibits a strongly iridescent appearance. Every one must have observed how luminous the eyes of animals of the cat species appear when partially concealed in the dark, an effect produced by the glistening of the *tapetum*, or tapestry at the bottom of the eye. The tapetum is absent in man and many of the minor quadrupeds, also in birds, and all fishes excepting the ray, in which it is of a beautiful silvery whiteness. "In the ox it is of a bright metallic green, changing to sky-blue; in the horse, buck, buffalo, and stag, it is a silvery blue passing to violet; in the sheep, pale golden green, sometimes bluish;

in the lion, cat, bear, and dolphin, pale gold yellow; in the dog, wolf, and badger, a pure white surrounded by blue;" and it is strikingly visible in the large sprightly eyes of the little squirrel monkey.

The function of the black pigment is to ensure perfection of vision by absorbing the redundant rays of light, a contrivance that has long been imitated by optical instrument makers in the manufacture of the telescope and microscope, &c., the tubes being lined on their inner surfaces with a black substance.

In albinoes the skin is white, or tinged with pink, the hair is white, the iris slightly grey, and the pupil of a pink or rose colour. This peculiarity is very observable in Isabella-coloured horses, and in many white dogs, ferrets, rabbits, mice, owls, and in some white and yellow canaries, which are said to possess red eyes. Some individuals of the human race present this phenomenon, which is due to the absence of the dark mucous pigment permitting the pellucid blood vessels of the choroid membrane to be seen.

"Clear as a beautiful transparent skin,
Which never hides the blood, yet holds it in."

According to M. Blumenbach, the celebrated German physiologist, this remarkable condition is never present in cold blooded animals. Albinoes often occur among the black races, and are sometimes met with among white people. They generally inhabit warm and damp regions, which prove so inimical to their enfeebled constitutions that they are seldom long lived, are frequently low spirited and morose; their eyebrows and eye-lashes being white, the retinæ are deprived of the natural screen which modifies the light as it falls upon the eyes; the consequence is that the superabundance of light descending upon these feeble organs, with their sensibility, already highly exalted, induces a perpetual blinking, thereby imparting to the owner a singular and most pitiable appearance.

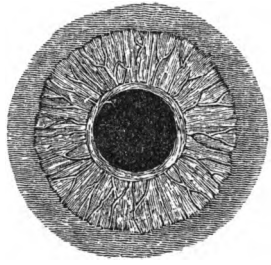
Another curious fact particularly worthy of remark relative to the colour of the eye, is the important connection and harmony that exist between the latter and the tints of the skin and hair: so intimately associated are they that where there is an excess or deficiency of the one, there is a like characteristic of the other, giving rise to the belief that the secretion is the same.

In the horse this want of the black mucous pigment constitutes what is generally called the "wall eye."

Simon Pontius, at a very remote period, called attention to the deficiency of the dark pigment in blue eyes, and M. Blumenbach considered the sensibility of blue eyes admirably suited to the Northern people, particularly when enveloped in the shades of their long twilight, while the deep black eyes of the negroes enable them to endure the brilliant glare of the vast sandy deserts and ardent sunbeams in the torrid zone.

Immediately behind the cornea, or little window of the eye, the iris is suspended vertically in the midst of the aqueous or watery humour. *Iris* is a Greek word, so called from its variety of colours resembling the rainbow. It consists of a thin circular membranous septum, or partition, perforated on the nasal side of its centre by a circular aperture termed the pupil. The round black spot, seen on looking into the eye, is the pupil, so called from the *baby*-like figures seen on it: the blackness is occasioned by the rays of light which are requisite for distinct vision being absorbed,

whereas the rays of light impinging upon the anterior surface of the iris round the pupil are reflected, imparting colour to the eye, and what is commonly called the colour of the eye is in truth the colour of the anterior surface of the iris.



The Human Iris, separated from the Eye and laid out flat.

The iris is composed of radiating and circular muscular fibres, admirably delineated in the above figure; the former converge from the circumference towards the pupil, which they serve to dilate; the latter encircle the pupil, which they can contract as the brightness of the light may require.

The movements of the iris are reflex, being determined by the action of light on the retina. By its dilatation and contraction it regulates the quantity of rays admitted through the pupil into the eye.

There is an almost infinite diversity in the colour of the eye in different individuals, or more correctly speaking, of the iris, which is, as we have just stated, the seat of the colour of the eye. The colours generally recognised are grey, whitish-grey, bright blue, bluish-grey, light hazel, hazel-brown; and in albinoes, pale grey, the prevailing colours being blue and hazel; but the most beautiful, expressive, and most coveted are unquestionably blue and dark brown.

It is indeed a curious fact long since observed by Aristotle, that the colour of the eyes of newly-born infants is invariably blue. It is asserted that kittens are always born with blue eyes.

The blue colour of the iris is not due to pigment, there being none on the anterior surface of the blue irides: it is simply an interesting phenomenon, like the blue of the atmosphere.

Modern observers have found that the development of the dark mucous pigment begins to change, or, in other words, the eyes begin to assume their permanent colour from the sixth to the eighth week, and in exceptional cases as early as the third or fourth week.

In beasts, birds, reptiles, and fishes, the colour of the eye varies according to the species, some possessing the most brilliant metallic lustre, while in some reptiles and fishes the iris is so thin and transparent that its posterior layer or *uvea* is visible, and is frequently of a silvery-white colour, as in the haddock and trout; or of a golden-yellow colour, as in the common perch. In the beautiful dragonet, it is of a brilliant fiery red; in the spotted goby, blue; in the red-eye, orange; and in the shark genus it is either of a bluish or greenish hue.

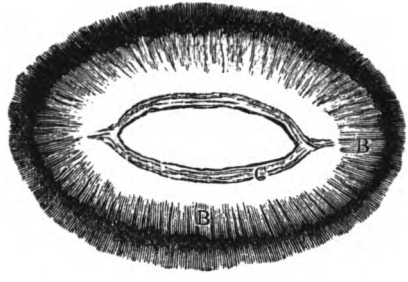
M. Georges Pouchet read a paper before the British Association, at Brighton, in 1872, on "The mechanism of the changes of colour in fishes and crustacea," in which he endeavoured to prove, from a series of experiments upon the optic nerve, that the change of colour was determined by the impressions received by the nervous system through the medium of the organs of sight; also, that blind fishes, and those in which the optic nerve has been severed, undergo no change of colour.

In many of the nocturnal beasts and birds of prey, the pupil is of an enormous size, and the iris is extremely active and sensitive to light.

The anableps, or four-eyed fish, claims a distinction which no other living vertebrated creature enjoys, namely, that of having two pupils in each iris.

The shape of the pupil in the different classes of animals presents an almost endless and indescribable variety. It is round in man and in the larger quadrupeds, birds, and many of the carnivorous animals, the dog, jackal, and racoon; among the amphibious animals, in most frogs, toads, and salamanders; among reptiles, the tortoise, chameleon, common lizards, cone-tailed lizards, colubrine serpents, water serpents, sea serpents, and in nearly all the burrowing snakes. In some ruminating animals, and in the whale, it is oblong transversely. In the horse it is transverse, and has its superior margin adorned by a five-pointed festoon. In the crocodile, and in the feline genus or cat species, the pupil is elliptical. Night-watching animals, such as the badger, fox, bat, and some nocturnal predaceous birds; also geckoes, and the tailless species of frogs, and many insects which pursue their prey at dusk, possess the extraordinary power of contracting or dilating the iris according to the exigencies of each

individual case to a much greater degree than mankind. The subjoined sketch of the iris of a lion gives a very good representation of the straight or converging fibres at B B, and the circular fibres at C.



In the dolphin the pupil is heart-shaped; in the ray, the superior border of the iris is branched, of a golden colour externally, but internally dark; when the pupil is dilated these branches are gathered up and lie between the vitreous humour and the superior border of the pupil, but when in use they become elevated, and cover it. In the gecko, a species of lizard, the pupil is somewhat oblong in form. In the nocturnal order of the thick-tongued lizards, in the viper-like cerastes, the true vipers, and the boa-constrictor, the pupil is narrow and vertical.

In the paroquet and other birds, the action of the iris appears to be voluntary; while it is a singular fact that the iris in the eyes of some fishes is not endowed with any intrinsic power of contraction, which is explained on the supposition that the diminished light in water is never too strong for the sensibility of the retina. In other fishes, this seeming defect is requited by a delicate gossamer-like veil, or internal eyelid, possessing a muscular apparatus over which the animal has perfect control. In the skate, this inimitable blind has been observed to have been drawn over the pupil like an eyelid during the day, and as nightfall advanced the animal has been seen to withdraw it to such an extent as appeared most congenial to its nature and predaceous habits. In the eye of the lamprey the iris appears to be simply a continuation of the retina.

The third or innermost tunic of the eye is the *retina*—a Latin term for network. It is a fine and delicate structure, which anatomists have shown, by a delicate microscopical dissection, to be composed of three layers, namely, the external, or Jacob's membrane, the middle, or nervous, and the internal or vascular. The

optic nerve takes its origin from a central part of the brain, and on entering the eyeball on the nasal side of its centre, it becomes separated into fasciculi, or small bundles of fibres, which pass through a sieve-like structure guarding the entrance, and styled by anatomists the *cribriform lamella;* after entering the internal cavity of the eyeball, they pass into a thin membrane having a concave surface covered with numerous veins, arteries, and absorbent vessels, upon which the threads of the optic nerve, which have been computed by anatomists to amount to one hundred and twenty-five thousand, are wrought into a delicate transparent network, constituting a living tablet, which is the seat of vision, on which the images of external objects are depicted, subsequent to undergoing refraction by the different humours of the eye.

The diameter of the retina, when removed from the eye, and spread out, does not exceed an inch and three quarters, yet, on this exceedingly circumscribed space, the scenery of a landscape can be pictured in miniature.

Sometimes from loss of power of the optic nerve, the retina becomes insensible, and total

extinction of vision ensues, without any externally discernible change in the organisation of the eye. This affection, in medical phraseology, is termed "amaurosis," and was the form of blindness that afflicted the poet Milton, and which he has so pertinently described in the following lines :—

> "These eyes, though clear
> To outward view of blemish or of spot,
> Bereft of light, their seeing have forgot;
> Nor to their idle orbs doth sight appear."

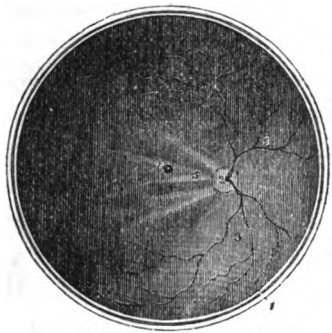
Who can adequately describe the fearful and melancholy calamities resulting from the total deprivation of sight! Ever doomed to pass long weary days, shrouded in darkness, even under the most favourable circumstances, the consciousness of an inability to enter into the many varied duties of social life, it might seem, would render existence sad and mournful; and yet, as God tempered the wind to the shorn lamb, so He graciously alleviates the afflictions of the blind, for we find that they are in general very cheerful, though the countless inconveniences and perils these unfortunate sufferers are inevitably destined to encounter far exceed any attempt at description. There are

few who are capable of appreciating, and fewer still who are sufficiently impressed with the magnitude and excellence of the benefits they are permitted to enjoy until deprived of them. Alas! this is too often true alike of the smallest, as well as of the greatest, of God's gifts. The beautiful and impressive thoughts of the blind poet are expressed in the following pensive strain:—

"Thus with the year
Seasons return; but not to me returns
Day, or the sweet approach of eve or morn,
Or sight of vernal bloom or summer's rose,
Or flocks or herds, or human face divine;
But cloud instead, and ever-during dark
Surrounds me; from the cheerful ways of men
Cut off: and for the book of knowledge fair,
Presented with a universal blank
Of nature's works, to me expunged and rased,
And wisdom, at one entrance, quite shut out."

The annexed diagram represents a posterior segment of a transverse section of the globe of the eye, seen from within. The three outer rings, marked 1, are the divided edges of the three tunics—sclerotic, choroid, and retina—the whole of the internal surface being covered by the latter. 2, marks the entrance of the optic nerve with the central artery of the retina, and

its branches 3, 3. 4, is the *foramen of Soemmering*, situated near the centre of the axis of the eye; it is a round spot, encircled by a yellow halo, named *limbus luteus;* the foramen is usually concealed by a fold of the retina, 5, and has only been found in those animals which have the axes of the eyeballs parallel with each other, as in man and monkeys, and some lizard-like reptiles.



Transverse Section of the Eye.

Recent observations and experiments have proved the function of the yellow spot of Soemmering to be that of acute, or *direct vision*, and the remaining lateral portions of the retina that of imperfect, or *indirect vision*. The very limited sphere of exact vision is so

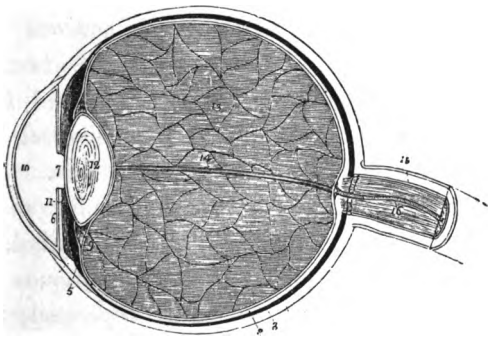
completely compensated by the mobility of the eye, as to render the fact unknown to most persons.

Having briefly described the sclerotic coat, or outer covering, the cornea or window, the choroid or second coat, the iris, and the retina, we next proceed to the consideration of the humours of the eye.

The interior of the eye is filled with three transparent humours, or lenses, named *aqueous, crystalline,* and *vitreous.* The *aqueous, or watery humour,* is transparent, colourless, and situated in the anterior portion of the eye, in the interval between the cornea in front and the crystalline lens behind. In the midst of this fluid the iris is suspended vertically, incompletely dividing the cavity into two unequal portions, termed the *anterior and posterior chambers,* respectively marked 10 and 11 in the diagram on the following page; the one in front of the iris being the largest; these communicate freely by means of the pupil. The quantity of aqueous humour is very small, rarely exceeding five or six grains in weight.

The location of the iris in a fluid, although apparently so simple, is a remarkable arrange-

ment, and admits of its function being exercised with greater facility than if it had been suspended in any other medium. This contrivance and functional aptitude are undoubtedly referable to foresight and design, and form one of the many proofs of the adaptation of means to an end, which are presented in such exhaustless profusion throughout the animal kingdom.



Longitudinal Section of the Globe of the Eye.

1, sclerotic; 2, cornea; 3, choroid; 4, ciliary ligament; 5, ciliary processes; 6, iris; 7, pupil; 8, retina; 9, canal of Petit, which encircles the lens (12); 10, anterior chamber of the eye; 11, posterior chamber of the eye; 12, crystalline lens; 13, the vitreous humour; 14, a tubular

sheath of the hyaloid membrane, which gives passage to the artery of the capsule of the lens; 15, neurilemma, or sheath of the optic nerve; 16, central artery of the retina, embedded in the optic nerve.

The *crystalline humour, or lens*, marked 12, is perfectly transparent, colourless like crystal, and elastic, and in man has the form of a doubly convex magnifying glass, situated directly behind the pupil, between the aqueous and vitreous humours. Its posterior surface is more convex than the anterior; it is enclosed in a fine transparent sac, which, in anatomical language, is called the *capsule* of the lens. The structure of this organ may be readily shown by immersing it in nitric acid, alcohol, or boiling water, when it becomes opaque and indurated, and may be easily separated into concentric layers, composed of delicate parallel fibres locked together by tooth-like projections.

The lens exhibits important changes at different periods of life. In early infancy it is found to be more globular, softer, and not so perfectly transparent as in after life.

In the healthy adult, the posterior surface is more convex than the anterior, also transparent

and perfectly free from colour. In the decline of life both surfaces are much less prominent, and not unfrequently its colour changes to a bright amber, sometimes intercepting the rays of light, and ending in cataract.

The method by which *long* and *short sight* is accomplished, is by certain movements of the crystalline lens being effected by the action of the ciliary muscle. When this muscle is inactive, the eye sees objects distinctly when far remote; but, in order to bring into the field of vision near objects, the ciliary muscle contracts. By this contraction the lens becomes more convex, and its refractive power is increased; so that to the long and short sight there is a complete and sapient adaptation. By the aid of an instrument called ophthalmometer, the dimensions of the cornea and the two surfaces of the crystalline lens can now be ascertained in the living eye, also their relative positions to each other. The curvature of the cornea, and the surfaces of the lens in many individuals who are free from disease, are very irregular; these defects, however, are so completely adjusted by the faculty of accommodation, that the majority of persons are quite

unconscious of their existence; although in some vision is indistinct at a distance, in others, where this accommodation is defective, squinting, and some of the most troublesome affections of the sight exist, which not infrequently baffle every attempt to cure.*

In fishes, the crystalline lens is nearly globular, and in most cases protrudes through the pupil, being subservient to their habits and economy. In the whale, marine and aquatic birds, and reptiles it is very convex, and remarkably so in birds that dive and fish for their prey, of which that tyrant of the finny tribe, the voracious cormorant, affords a good example. Of the three humours the *vitreous*, marked 13 in the diagram, so named from its fancied resemblance to melted glass, is the largest in quantity, and lies at the back of the crystalline lens, occupying nearly the two posterior thirds of the orb; it is a transparent gelatinous-like substance, invested by a very

* For a list of the defects exhibited by the different structures of the Eye, and its imperfections as an optical instrument, the reader is referred to H. Helmholtz's popular Lectures on Scientific Subjects. Published by Longmans, Green & Co., London.

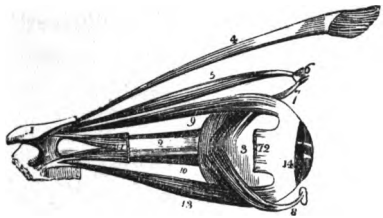
delicate transparent membrane called the *hyaloid*, which comes from the Greek word *hualos* (resembling glass). This membrane, by the aid of a blowpipe, is seen to consist of an inner and an outer layer; the inner gives off processes inwards, forming cellular compartments for enclosing the vitreous humour. By this simple and admirable contrivance, the optical mechanism of the eye is preserved, and in case the outer layer or membrane becomes accidentally punctured, or even lacerated, the humour is not injured or lost. The eyes of insects do not possess this mechanism, and vary much from this organ in the higher grades of animals.

The muscles by which the globe of the eye is moved in man are six in number. They are attached at one extremity to the bony walls in the interior of the orbit; by the other they are inserted into the sclerotic coat of the eyeball; and, by their excellent adjustment, the eye is moved in all directions with remarkable facility.

In the diagram on page 31, figure 1 represents a portion of the sphenoid bone; 2, the optic nerve; 3, the globe of the eye; 4, levator palpebræ muscle, which raises the upper eyelid; 5, superior oblique muscle, or *trochlearis*, so

designated from its tendon passing through a fibro-cartilaginous, or partially osseous pulley, 6, at the inner margin of the forehead bone, its tendon (7) is then reflected obliquely outwards and downwards to be inserted into the sclerotic coat—its action is to roll the eyeball inwards and forwards, carrying the pupil outwards and downwards; 8, is the inferior oblique muscle, which takes its bony origin from the lower edge of the orbit, and passes obliquely backwards, to be inserted into the outer and back part of the eyeball; its action is to carry the eyeball outwards and backwards, and to turn the pupil outwards and upwards. When the superior and inferior oblique muscles act simultaneously, the globe is drawn forwards; at the same time the pupil becomes slightly everted, so as to allow of the utmost possible range of vision. 9, levator oculi, or erector of the eyes, sometimes termed *superbus*, from its action imparting an expression of pride, or haughtiness; 10, adductor oculi, which draws the eyeball towards the nose: it is also called *bibitorious*, having reference to the cup, or orbit, towards which the glance is inclined; 11 and 12 are portions of the abductor oculi, which

muscle turns the globe outwards, and is sometimes styled *indignabundus*, from its inducing an expression of scorn, anger, or indignation; 13, the depressor oculi, or depressor of the eye, also named *humilis*, from its denoting humility, or sorrow; 14, marks a white tunic, termed the *tunica albuginea*, formed by the expansion of the tendons of four muscles.



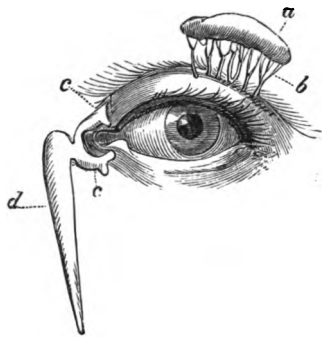
Muscles of the Eyeball.

The various additional actions accomplished by the muscles of the eyeball, and in connection with the mechanical and hydraulic apparatus of that organ, either singly or conjointly, are too numerous to admit of detailed description.

Although man and the greatest number of quadrupeds, have six muscles affixed to each eye, horses, oxen, sheep, deer, swine, and other

quadrupeds possess a seventh muscle, technically termed the *suspensorius oculi*, said to have been originally observed by the celebrated physician Galen, who died at Pergamus, in his 90th year, A.D. 193.

Its distinctive office is manifestly what its name implies, that of sustaining or suspending the globe of the eye, more especially when these creatures are in the act of grazing, or otherwise feeding, for it is sufficiently obvious that on such occasions their heads and eyes are directed towards the earth.



a, Lachrymal Gland; *b*, its Ducts; *c*, *c*, the small Orifices; *d*, Lachrymal Duct terminating in the Nostrils.

The *lachrymal gland* is flat, and oval in shape, situated at the upper and outer corner

of the orbit, near the temple, its lower border being in close proximity with the upper eyelid, it secretes the tears which are poured upon the globe of the eye by means of eight or ten minute ducts or tubes *(lachrymal ducts)*.

Many quadrupeds are provided with two lachrymal glands. The herbivorous whales have one, but ordinary whales have none. In rodents—for example, the hare and rabbit—the gland is very large; it also exists in the higher order of reptiles, but not in frogs, so that although these despised animals may croak, they cannot shed tears. Perhaps this assertion demands qualifying, inasmuch as recent investigations have proved that the large, brilliant eyes of frogs, toads, salamanders, and some others, are moistened by a secretion strongly resembling tears. The tears have a twofold office, they not only facilitate the motions of the eyelids, but are highly successful in freeing the surface of the eye from impurities and offensive particles, the irritating presence of which invariably provokes an excessive flow. It is not unworthy of remark that infants seldom shed tears during a fit of

crying before the third or fourth month; exceptional cases have, however, been met with, even as early as the third week of infant life. From close and long continued observation, it has been ascertained that some of the higher order of animals do occasionally weep—as, for instance, the Indian elephant.

At the inner angle of each eye there is situated a small red fleshy substance termed caruncle *(caruncula lachrymalis)*, which contains small glandular follicles, and from its surface a number of minute hairs arise, which serve to collect extraneous substances that may accidentally fall into the eye; on each side of this small body, and on the edge of each lid, there is a minute opening *(punctum lachrymale)*. These two apertures are ever absorbing the tears, which are conveyed by two small canals *(canaliculi)* into a slightly dilated part named *lachrymal sac*, the latter terminating in another canal possessing the qualities of a syphon, termed *nasal duct*, which discharges them on the interior of the nostrils, through a perforation in the bone, and from which surface they are evaporated by the warm air expired from the lungs during respiration.

The eyeball, in its normal position, reposes upon a thick, soft bed of fat, and in the higher mammalia, and in vertebrated orders generally, it is more or less encompassed with bone. In some of the ichneumons or "Pharaoh's rats," as the Egyptians call them, in the coatimondi, which somewhat resembles the racoon, and in the mangue, the osseous orbital ring is incomplete, and in a group of minor quadrupeds, entitled Hyracidæ, the malar, or cheek bone, constitutes a perfect orbital ring.

In man the orbit is a conical cavity, and parts of seven different bones contribute towards the formation of its walls; nine distinct apertures exist in their surfaces, eight of which afford transmission to blood vessels and nerves, and one—the nasal duct—as we have already stated, conveys the tears to the back of the nostrils.

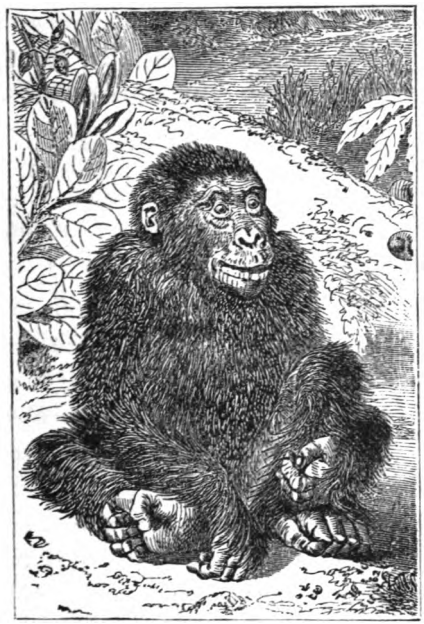
Below and externally, the orbit is bounded by the *malar or cheek bone*, and above by the eyebrows and the *arch of the frontal or forehead bone*, which forms a strong osseous fortification eminently calculated to defend the eye from the effects of violence or injury, and invariably these prominent parts receive the brunt

of a blow, and what, in common parlance, is termed a "black eye" is the result.

The arch of the frontal bone, or projecting plate of the eyebrows, is particularly well-developed in man, the horse, lion, and singularly conspicuous in the hammer-headed shark; and among the feathered creation we may mention the golden eagle; and among reptiles, the alligator, viperine serpents, and true vipers. It is also remarkably strong and prominent in the formidable and extraordinary-looking creature called the gorilla or "king of the African forest," as he has been titled by way of eminence. In form the gorilla is said to approach most closely to the human species, but whether there is any real kindred and affinity between man and the highest orders of the lower animals is an old and much-vexed question, which has been eagerly discussed, and has agitated the minds of both ancient and modern zoologists, without producing any valuable results.

Professor Owen, like the great anatomist and naturalist, Baron Cuvier, courageously defends the Scriptural dignity of our origin. Other authorities are as rashly determined to humiliate

man's pride by boldly declaring him to be lineally descended from a marine ascidian, that is, a headless and eyeless mollusk, consisting of a



The Gorilla.

gelatinous sack, with two orifices, and possessing a heart, respiratory and digestive systems, yet incapable of transferring itself from one

place to another, and is permanently attached to some submarine substances, chiefly rocks and shells. Other speculators, again, advance the gorilla to the high honour of being man's congener, although not quite so civilised as he whom we have ever regarded as the highest and most perfect type of organisation,—

> "Who not prone
> And brute as other creatures, but endued
> With sanctity of reason, might erect
> His stature, and upright, with front serene,
> Govern the rest."

Some naturalists assign the gorilla to the same genus as the chimpanzee, but consider the chimpanzee approximates more closely in internal conformation to the human kind than to the gorilla. The French and American naturalists agree in placing the gorilla below the chimpanzee in the zoological series, while other authorities are inclined to place both the gorilla and chimpanzee below the hylobates, or long-armed apes; others, again, regard the gorilla as a distinct species.

It is an interesting anatomical fact and distinctive peculiarity that the fingers and toes of the gorilla are webbed to a much greater

extent than in the chimpanzee; the hands of the latter, therefore, are more nearly allied to those of mankind.

Some of the earliest historians give evidence of having known by name the gorilla more than five hundred years before the Christian era, yet its existence had been undetermined since the days of Herodotus, until discovered in Africa by Dr. Savage, an American missionary, in the year 1847. Between the years 1855 and 1861, the "land of the gorilla" was explored by the intrepid M. Du Chaillu, whose unprecedented collection of sixteen specimens has been consigned to the British Museum. In their native country, the dense tropical forests of Africa, the gorillas are said to congregate together and march in companies. The strength of the full-grown gorillas is so great that they are seldom, if ever, taken alive. According to Andrew Battel, ten men, unarmed, would be unable to conquer a single adult gorilla. They have been observed imitating men's actions, assuming an erect attitude, not unfrequently collecting and carrying tusks of ivory on their shoulders until they have become totally exhausted. It is the custom of negroes and others, when

journeying through the forests, to light fires at night, to enable them to cook their food and ward off any savage beasts which might be lurking in their vicinity. In the morning, after their departure, we are told the gorillas collect round the fires until they die out, not being endowed with sufficient instinctive sagacity to put on more wood, neither do they appear to learn with frequent experience. Most authorities are agreed that they possess no understanding higher than instinct. Buffon has truly observed "that no disposition of matter can constitute a mind; and that the body, how nicely soever constructed, is constructed in vain, when no soul is infused into it, for the purpose of directing its operations." The strong parental affection and extreme solicitude evinced by the gorilla for its young is truly interesting. Many instances have been witnessed and justly eulogised by adventurous hunters, in which the gorilla has with fearless and unflinching pertinacity endeavoured to defend its offspring, even when exposed to the most imminent danger, choosing rather to die than desert its young. These creatures are chiefly arboreal in their habits, and their food

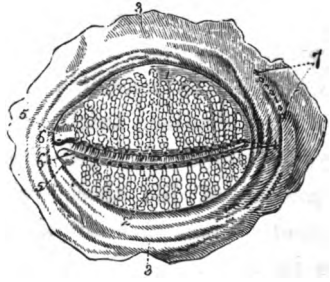
consists principally of nuts and fruits, but they exhibit a decided preference for sugar-canes. Each adult gorilla is estimated to consume not less than a barrel of food per day.

The poor benighted natives have the heads of these animals mounted on long poles, to which they attach mystical notions, and in times of trouble invoke them to avert impending evils.

But to return to our subject.. The concave roof of the orbit, or cavity in which the eye-ball is lodged, forms a part of the floor of the skull, and in this locality the bone is as thin as parchment, which circumstance renders it liable at any time to be perforated by sharp instruments thrust into the orbit, and wounds of the brain from such accidents are by no means uncommon. Henry II., of France, was accidentally killed at a tournament, in 1559, by the lance of the Scottish knight, Montgomery, penetrating the brain in this direction. At advanced periods of life these orbital plates not unfrequently undergo absorption, and have large holes in them.

In man, and in the greatest number of terrestrial animals, the organ of vision is defended from injury, both when asleep and awake, by

an upper and a lower lid; the motions of these vital curtains are both voluntary and involuntary, and they can be drawn with almost the swiftness of lightning; they are lined by a smooth folding membrane, which greatly aids the motions of the eyeball, and is called *conjunctiva*, because it unites the globe of the eye with the eyelids; it is, moreover, prolonged into every pit and depression on the anterior portion of the eye. In man, the upper eyelid is the largest, and allows of a much greater power of motion than the lower; it descends below the centre of the eye, concealing the cornea; the latter, by the way, ascends at the same moment insensibly under the lid.



The Meibomian Glands, as seen upon the inner aspect of the eyelids. 1, Upper lid; 2, Lower lid; 3, 3, Conjunctiva; 4, Openings of the Meibomian glands, along the free border of each eyelid; 5, 5, Papillæ lachrymales; 6, 6, Puncta lachrymalia; 7, Apertures of the ducts of the lachrymal gland.

On the inner margin of each eyelid from thirty to forty glands *(Meibomian glands)* are arranged like "parallel strings of pearls;" they are more numerous in the upper than the lower lid, and secrete a thickish fluid upon the borders of the lids, a specific provision for lubricating them and cleansing the eye in the act of winking; and it is not improbable that, from its wax-like property, it may, under ordinary circumstances, prevent the tears from trickling over the lids upon the cheeks.

Muscle of the Eyelids.

The eyelids are provided with an appropriate group of muscles, by which their various movements are effected; the two mainly instrumental in opening and closing them are the *levator palpebræ* and the *orbicularis palpebrarum*; the former is well displayed in the accompanying sketch, which represents a profile of it in its natural position.

Among quadrupeds, birds, and reptiles, a third eyelid, or nictitating membrane exists. In birds, the sperm whale, frogs, and some lizards, the lower eyelid is not only larger, comparatively speaking, than in man, but is more movable; but to this we have an exception in the ostrich. In this bird the upper eyelid is ornamented with lashes and can be moved with the greatest freedom. In some rays and skates the upper eyelids are partially, while in others they are entirely adherent to the eyeballs, and are termed adnate, or growing together. The Horned frog of Cayenne and Brazil is remarkable for the short, sharp, horn-like processes into which the upper eyelids are converted. In aquatic animals the eyelids are very imperfectly represented; but perhaps the greatest and most astonishing diversity prevails in lizards. Usually two distinct movable eyelids are met with, yet some are completely destitute of eyelids; for example, the family of blind lizards and the Americima, a native of Brazil; while in others, for instance, some of the slender-tongued lizards, they are very rudimentary and not seldom entirely absent; in others again, they form a portion of a circle, and in the thick-tongued,

nocturnal lizards they are perfectly circular and immovable, while in some specimens they can be opened and closed by means of muscles. The snake-like lizards, which seem to form a transition class between the lizards and snakes, are supplied with eyelids. The true-scink (a kind of lizard) is endowed with distinct movable eyelids. In the gape-eyed scink these organs are circular in form, very indistinct, incapable of motion, and are frequently wanting. In a little scink called the Nimble Mabouya, a native of Jamaica, we have a beautiful and practical exemplification of great wisdom and provident care exerted for the preservation of the eye and well-being of this apparently mean reptile. In the lower eyelid, which is larger than the upper, there is a transparent circular window, which, when the eyelids are closed, corresponds to the pupil, thus enabling the animal with closed eyelids to perceive and pursue its prey in the dark corners of old walls and among loose stones with absolute security from injury. The large immovable green eye of the gecko (a nocturnal lizard) resembles that of the chameleon, in being defended by a single eyelid having a wide oblong opening in front.

Serpents seldom possess eyelids, which circumstance imparts to them a strange and fierce aspect, having their eyes fully exposed and stationary. In a genus of harmless serpents (*Amphisbœna*), natives of South America, extremely rudimentary eyelids have been discovered, which in form describe a portion of a circle; and another genus of serpents (*Acontias*) possess only the lower eyelid, which in the spotted acontias of South Africa is scaly and diminutive, yet in each case they are admirably consistent with their required functions and the different modes of life assigned them. The lower eyelid in some tortoises, lizards and frogs is transparent. In the genus *Octopus*, or sea-spider, the eyelids are often transparent, through which their large, fixed, shining eyes are signally conspicuous by moonlight. All the invertebrate animals, with one exception (*cephalopodous mollusca*), are remarkable for their total want of eyelids.

The direction of the opening of the eyelids in different creatures is not a little curious. In mankind generally it is almost horizontal, while in the Chinese, as may be

seen in the accompanying illustration, it forms an oblique cleft, which is also the case in the fox, wolf, land-tortoise, and some other animals.

Chinese Lady.

The *eyebrows*, not unlike an obliquely "thatched penthouse," divert the perspiration as it trickles down the forehead, from entering the eyes, and moving by means of the muscles of the forehead in opposite directions, regulate to some extent the rays of light in their course to the eyes, and impart beauty and expression to the varied passions. The eyebrows are wanting in the gorilla and vultures, but abundant in falcons; and in the common seal they consist of a few stiff hairs, which form a palisade well calculated to defend the eye.

The soft, silky *eyelashes* are more numerous and longer in the upper than the lower lid, they are arranged on the border of each lid in two or three rows, and are curved in opposite directions, in order to prevent their becoming entangled. The eyelashes, like the eyebrows, perform a double duty, they aid in veiling the eyes from too intense glare of light from above, and in excluding and brushing away offensive substances. Men and monkeys have both eyelids fringed with lashes, in other animals they only exist on the lower eyelid; they are exceedingly thick and strong in some birds which inhabit groves and dense tangled bushes.

We have endeavoured to compress into the few preceding pages a general outline of the structure of this wonderful little orb, the exquisite mechanism of which puzzles the knife of the anatomist, unfolds lessons of design that astound the sceptic and convert the waverer. So long as man loves the excitement of research, so long as he values truth above all worldly distinctions, so long will he ponder over this beautiful microcosm with enduring and paramount interest. The eye in man has ever been

esteemed the paragon of the senses and the exponent of those passions and emotions which elevate or depress the human soul, on whose living dial are ever being visibly portrayed with equal force and delicacy—

"Love, Hope and Joy, fair Pleasure's smiling train,—
Hate, Fear and Grief, the Family of Pain."

CHAPTER II.

THE STRUCTURAL PECULIARITIES PRESENTED BY THE EYES OF INFERIOR ANIMALS.

THE infinite diversities and peculiarities of construction exhibited by the eyes of the different classes of animals are replete with wonders that merit special attention. Perhaps no other organ of sense affords a more striking illustration of foresight and design, or one wherein mechanism and function are so thoroughly apposite, and, in structure, so marvellously adjusted to the varying exigencies of its use.

The largest eyes, in proportion to the weight of the animals, are found in birds, particularly the rapacious nocturnal tribes; for example, in the owl genus. The sight of these birds is so very acute and piercing as to enable them to discern and capture mice, as they fly over a meadow at dusk or by moonlight, or seize their scaly prey as they glide noise-

lessly over the surface of shallow streams. The stately elephant, the rhinoceros, the hippopotamus and whale, with the ferocious crocodile and alligator, possess nearly the smallest eyes; but the most diminutive are those of the shrew and common mole, the eyes of the latter being so minute as scarcely to be visible to ordinary observation.

We learn from the revelations of geology that the large saurians which existed antecedent to our crocodiles, iguanas, and lizards, possessed organs of vision far exceeding in size any known living creature. According to Dr. Buckland, the orbit in the head of an adult *ichthyosaurus platyodon* measures fourteen inches in diameter. What, then, must have been the magnitude of the eye corresponding to a cavity of such enormous dimensions! If we travel farther back still, to a period prior to the existence of the animals just cited, we find, amongst the fossil remains, specimens of compound eyes, analagous to those of the *crustacea* now living. Eyes, in every respect similar to those of scorpions, have been found in the large fossil scorpions in the coal formation of Bohemia.

Animals possessing the most acute vision are eagles, amongst birds; the salmon, amongst fish; the lynx, amongst quadrupeds; but, certainly, the most striking, and that gifted with the most delicate mechanism, is possessed and enjoyed by man alone.

Let us, in the first place, examine the eye of a bird, which, in point of importance, stands pre-eminent among the organs of sense. In some birds a complete, while in others an incomplete circle of exceedingly fine delicate radiating feathers surrounds each eye, which are not infrequently most elegantly spotted and brilliantly variegated. Of the former, we may mention the family of owls, and the kakapo of New Zealand. A genus of birds nearly allied to the warblers designated *Zosterops*, inhabiting Africa, Asia, and Australia, have a disc of pure snowy-white feathers surrounding each eye. The blue-eye, which is peculiar to New South Wales, has each eye adorned with a brilliant blue and green circular girdle. The eyes of the ringed guillemot of Europe are surrounded with white rings, while those of the white-eyed fly-catcher of America are encircled with

orange-coloured rings. The cirl bunting, which is abundant in the South of Europe, has a yellow line above and another below each eye, and between these a black line traverses the eye. In other birds, again, the eyes are encompassed either wholly or partially with naked skin, variously coloured, blue, green, scarlet, black, white, and yellow; in some a variety of tints are beautifully intermingled, and impart to the birds a very peculiar and pleasing appearance. As examples of those in which the eyes are entirely surrounded with naked skin, we may mention the common turkey, the pheasant, king vulture, short-tailed eagle, black stork, the graceful ground-dove of Australia, the didunculus (a native of the Navigator's Islands), the common curassow (an inhabitant of the forests of tropical America), the crowned-eagle of Africa, the oyster-catcher, Javanese peacock, and the white spoonbill. The eyes of the six first mentioned are encircled by naked scarlet skin, while the six latter are of a bright orange or yellow colour. Among birds whose eyes are partially surrounded with naked spaces or patches of red or brilliant scarlet skin, occasionally diversified

with tinges of blue and other colours, we may name the black grouse of England and Scotland, the partridge, the male capercailzie or wood-grouse, the lunulated honey-eater (a resident of Australia), and the paradise grackle (an inhabitant of India and the Philippine Islands). In the cormorant, the wild swan, the great heron (a native of North America), the garrulous honey-eater of New South Wales, and that wonderful imitator of the human voice, the jungle grackle (met with in India and Ceylon), the naked markings are of a bright yellow hue. In the guinea-fowl, the gannet or solan goose, the partridge bronze-wing, and the undulated hornbill, the naked markings are blue; also in the blue-faced honey-eater of New South Wales; hence the specific appellation of *cyanotis* or "blue-eared." In the blue and yellow maccaw, and the Carolina parrot, the naked skin surrounding the eyes is white. In the common pelican it is flesh-colour; and in the great-crested grebe and the tame swan a patch of black bare skin is situated between the bill and each eye. In the common heron and little egret heron the bare skin is greenish. In the stone curlew, beneath each eye, there

is a yellowish-green space, and the eye of the American turtle-dove is surrounded by a greenish-blue naked space.

The eyes of birds, like those of mankind, exhibit an almost boundless diversity of colour, being infinitely varied in the brilliancy and blending of their tints. The black swan, the great-crested grebe, the water-hen, the little bustard, white and yellow canaries, the Java sparrow, the Mississippi kite, the ground-dove of Australia, the red-eyed fly-catcher of America, the pochard (a marine duck), the bee-eater (found in many parts of Asia and Africa), and many others, have red eyes. The eyes of the golden eagle, the white-tailed eagle, the common heron, the bittern, the osprey, the great snowy owl, the black-backed gull, the silvery gull, the sparrow-hawk, the ring-dove, the turtle-dove, the ivory-billed woodpecker, the cuckoo, and scores of others, are either yellow or of a bright orange colour. Blue eyes are met with in the black grouse, the tawny owl, and the satin bower bird of Australia. Black eyes are seen in the robin-redbreast, the American turtle-dove, the long-tailed humming-bird, and the vervain humming-

bird. The jackdaw, the Australian crow, the gannet, and the white-crowned pigeon of Jamaica possess white eyes. The eyes of the white-winged chough of South Australia are of a bright scarlet colour, those of the oyster-catcher and the Numidian crane are of a crimson colour. The eyes of the American whip-poor-will are bluish-black, those of the fishing-cormorant of China are of a beautiful sea-green, while those of the plotus consist of three coloured rings, orange, buff, and brown. The Cornish or red-legged crow has a red and blue circlet upon each eye. The banded-tanager (a denizen of Brazil), the bee-eater, and blue titmouse have a black streak, and the dotterel a white streak passing through each eye. Lastly, the prevailing colour in the eyes of birds is hazel, familiar examples of which are met with in the sparrow, the wren, the chaffinch, wheatear, the missel thrush, the nuthatch, the wood-grouse, the magpie, the common pelican, the quail, the pied wagtail; also the large beautiful, glancing, glittering eyes of that especial favourite, and certainly the sweetest of the feathered minstrels, the nightingale, resemble hundreds more in being hazel.

The *colour* of the *eyelids* of some birds is well worthy of a passing notice. The eyes of the blue-eyed yellow warbler (a native of the United States) and the white-bellied pigeon of Jamaica are surrounded with blue eyelids; the bearded vulture and the Cornish chough with red lids; the white-crowned pigeon of Jamaica with purplish-red; and the kestrel and solitary sparrow, common in the Southern parts of Europe, with yellow.

In the feathered tribes the swiftness of their movements is indispensably necessary to their safety and continued existence; it is, therefore, absolutely essential that their sense of sight should be more acute, and their sphere of vision have a more extensive sweep and compass, than in other orders of animals. We accordingly find the mechanism of their organs of vision perfectly conformable to their requirements. The following mode of adjustment of the eye in birds, for vision at varying distances, was long entertained by some. In most species to which we have already adverted at page 4, a bony, while in others a flexible hoop encircles the broadest part of the eye, which, by restricting the action of the

muscles to that part, was thought to augment their lateral pressure upon the globe, and by this expedient its axis became lengthened, adapting the eye for viewing near objects; moreover, there is a highly vascular and elastic structure named *pecten or marsupium*, which was considered to retract the crystalline lens as occasion demanded, so as to qualify the same eye for perceiving objects at a distance. By these special contrivances, it was believed, the eyes of birds could be made to flit from a very near object to one far remote. According to Dr. R. J. Lee, however, who has recently made some most valuable researches on the organ of vision in birds, the power of accommodating the eyes of the latter, for distance, upon which he conceives their perfection of sight depends, is principally due to the ciliary muscle and its opponent, the posterior elastic ligament, this, of course, being subject to the various degrees of development met with in different animals. The ciliary muscle is particularly well developed in birds, in nocturnal beasts of prey, but is wanting in fishes. A very rudimentary pecten has been discovered in some fish and reptiles. Mr. Glaisher has proved by

aeronautic experiment the possibility of birds being able to see a distance of two hundred miles, for when elevated to a height of half-a-mile above the earth's surface, he was able to distinguish the course of the Thames from the Nore to Richmond. The hawk, which lives by rapine, as it hovers and circles in the air, at a height so prodigious as to be almost imperceptible to the keenest eye, can distinctly espy the lark on the surface of the earth, and swoops down upon it with amazing celerity and precision. That hawks are guided to their prey by the sense of sight, was a fact well known to ancient falconers, for in capturing them they were accustomed to place as a decoy, a small animal or bird, upon which the unsuspecting hawk pounced, and thus became a victim to their cunning devices. The South American condor or vulture is one of the largest and most remarkable of predaceous birds, and is believed to ascend to a greater height than any other bird. It soars aloft as high again as the highest peak of the Andes, far beyond the line of perpetual snow, until it assumes in the eyes of the beholder the appearance of a mere black speck. This bird

possesses only one pair of beaming eyes, yet we are assured that its sight is so powerful as to embrace a field of vision of almost unlimited extent. Travellers affirm that when it wings its fearless flight to inconceivable altitudes, the circumference of its vision covers an area equal to the whole of Germany; and at these vast heights it can discern its prey in the plains below, upon which it can at once precipitate itself with irresistible velocity. The eye of the hen is endowed with the properties of both the microscope and telescope, enabling her to see objects at various distances.

We have already stated that a third or supplementary eyelid exists in birds, it is called

Eye of the Secretary Bird, showing the passage of the Nictitating Membrane across the Cornea.

nictitating or *winking membrane*, and may be readily seen in the eye of the domestic hen;

it is also very conspicuous in the owl, the cassowary, and the secretary-bird. It is a somewhat transparent elastic substance, of a triangular form, which, when inactive, lies folded up at the internal angle of the eye, and by means of two special muscles, named, from their shape, the *quadratus* and the *pyramidalis*, can be drawn instantaneously over the eye, like a curtain, its retraction being effected at will by its own elasticity. The nictitating membrane has been conferred with evident design; without such a provision, birds would be in constant danger of striking various objects when threading their way through tangled bushes and hedges in search of food; without this protection the rapidity of their movements would have tended more to evil than good. But this is only one of the offices performed by this third eyelid; it also wipes the eye in the act of winking, whilst its most essential characteristic function is that of interrupting the garish light of day; for without this beautiful shield, some birds would experience the greatest discomfort, while others would become confused and perfectly helpless. By the aid of this interpos-

ing veil, eagles are deemed capable of steadfastly fixing their bold bright eyes on the dazzling beams of the meridian sun.

The Umbrella Bird.

The umbrella bird *(Cephalopterus ornatus)* is adorned with a large elegant and graceful crest, which not only beautifies its head, but is of evident service in forming a superb natural sunshade for its eyes. If divested of its crest and plume, its appearance would bear no inconsiderable resemblance to the common black crow of this country. It is found in the Brazilian dominions. The excellent description, from the pen of Mr. Wallace, of the bird's crest, and its fitness for accomplishing the end we have just mentioned, namely,

that of screening the eyes from the sun's rays, merits special quotation:— "The crest is perhaps the most fully developed and beautiful of any bird known. It is composed of long slender feathers, rising from a contractile skin on the top of the head. The shafts are white and the plume glossy blue, hair-like, and curved outwards at the tip. When the crest is laid back, the shafts form a compact white mass, sloping up from the top of the head, and surmounted by the dense hairy plumes. Even in this position, it is not an inelegant crest; but it is when it is fully opened that its peculiar character is developed. The shafts then radiate on all sides from the top of the head, reaching in front beyond and below the tip of the beak, which is completely hid from view. The top then forms a perfect, slightly elongated dome of a beautiful shining blue colour, having a point of divergence rather behind the centre, like that in the human head. The length of this dome, from front to back, is about five inches, the breadth from four to four and a half inches."

Many quadrupeds possess a structure termed the *haw*, corresponding to the nictitating

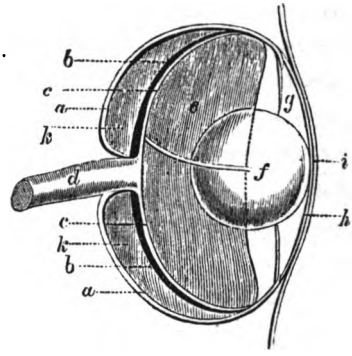
membrane in birds, and although they differ somewhat in structure, yet their functions are not very dissimilar. It is very observable in the horse; and of pre-eminent utility to the camel, as the latter journeys over the vast burning sandy plains of the East. It also exists in some sharks, herbivorous whales, alligators, crocodiles, tortoises, turtles, lizards; and amongst the Amphibia, frogs, toads, and salamanders. It is particularly large in the feline genus. In man it is situated behind the caruncle, and is very minute and rudimentary. It is a thin piece of cartilage, semi-lunar in form, situated betwixt the eyeball and the inner corner of the orbit; its surface is lubricated by an adhesive fluid, which greatly facilitates its motions, and is secreted by a special gland, called *Harderian*, placed at the nasal side of the orbit. The action of the haw is both voluntary and involuntary, and can be made to pass with the utmost ease and freedom, not only rapidly, but with great force, across the eye, removing particles of dust, insects, and other extraneous substances that may have accidentally adhered thereto, which might excite irritation and produce obscurity

of vision. The *Gland of Harder* is found in very many quadrupeds, in birds and reptiles, being specially well developed in the crocodile, the elephant, and animals of that order, and in a few animals of the rodent type, as hares and rabbits, also in sloths, but absent in man.

In the structure of the eye of Fishes we find the display of Divine wisdom infinitely diversified, yet in every instance complete, and in accordance with special needs, allowing fishes to see equally well in water and in air. In fishes the eye is defended from injury by a continuation of the transparent skin of the head, which unites with the conjunctiva. The sclerotic or outer tunic in the eyes of fishes is more nearly allied to that of birds than to that of man. In the whale it is as dense as tanned leather, while in some fishes plates of cartilage are not infrequently found enclosed in its meshes, while in others it is changed to bone. For fuller details appertaining to the structural changes of this tunic, see page 4.

The aqueous and vitreous humours in the eyes of fishes are insufficient in quantity to refract the light to a focus on the retina, this property is therefore delegated to the crys-

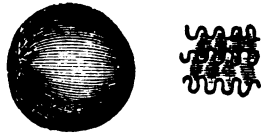
talline lens, which, instead of being almost doubly convex in form, as in man, is globular, and a glance at the following diagram will show that the focus of the lens is short, in proportion to the increase of its refractive power;



Eye of a Fish:—*aa*, the Sclerotic Coat; *bb*, the Choroid Coat; *cc*, the Retina, expanding from the Optic Nerve, *d*; *e*, the Vitreous Humour; *f*, the Crystalline Lens; *g*, the Aqueous Humour; *h*, the Cornea; *i*, the continuation of the Skin covering the Cornea; *kk*, a deep-red substance situated between the two layers of the Choroid, named *Choroid Gland*, covering the Optic Nerve, the precise function of which is unknown.

consequently, it is located much nearer the retina than in man, and in front projects through the pupil into the anterior chamber, so much so indeed, in some fishes, as to be in actual contiguity with the posterior surface of the cornea.

The structure of the lens of fishes is very singular; "the hard central portion is composed of a succession of concentric, transparent plates, the surfaces of which, though apparently smooth, have a lustre like that of mother-of-pearl." These plates are composed of flat fibres, about the 5,500th part of an inch in breadth, and are united reciprocally by means of a series of curved borders, the convexity of one curve fitting the concavity of another, affording, when viewed under the microscope, an exceedingly beautiful and interesting sight. The number



Eye of a Fish. Lens, with its Fibres.

of these tooth-like projections in each fibre has been computed by the distinguished philosopher, Sir David Brewster, to amount to 12,500. The lens contains about 5,000,000 of fibres; the aggregate of these minute teeth, therefore, amounts to the prodigious number of 62,500,000,000; a number well calculated to bewilder, and to fill the mind with amazement.

In fishes, the globe of the eye is more or less depressed in front, and it is provided with six muscles by means of which the globe can be lengthened or flattened at will. This action may be witnessed in the bright and peculiarly placid eyes of gold fish.

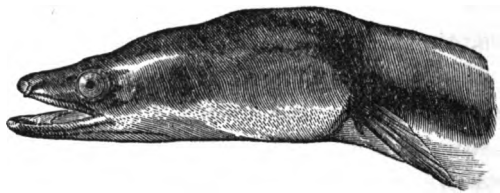
In comparing the eye of a fish with the eye of a man, or the eye of a bird, many important points of distinction are found to prevail. In the two latter the sphere of vision is much more extensive than in the former. The latter are provided with eyelids. Birds have also a nictitant membrane, whereas in most fishes they are absent. In this, however, we have some exceptions. The shark and the genus *Periophthalmus* are in possession of an eyelid, and one of the carp kind *(Bodian Palpebratus)* and the ray and skate have a rudimentary structure much resembling a nictitating membrane situated above each eye. Again, man and birds have lachrymal glands, which, as we have before stated, secrete the tears, but fishes, living and moving in a liquid element with which their eyes are ever being bathed, have no need of such organs.

The general form and construction of the eyes of *Amphibians* partake both of the aquatic and terrestrial animals.

The sight of that largest of all animated forms, the Whale, is extremely acute, and the eye is so organised as to enable it to descend to a greater depth, and sustain a greater weight of sea-water than its most dangerous enemies, the porpoise, the sword-fish, and the shark. If assailed while floating on the surface of the water, it is so conscious where its safety lies, that it instinctively descends perpendicularly to a depth of more than 1,000 feet, and by thus submitting its antagonists to a sudden and insufferable pressure, they are compelled to relinquish their prey. It is presumed that the whale, under this extraordinary instinctive consciousness, when struck by the harpoon, plunges violently to the bottom of the ocean.

The Dugong is the only animal known to graze at the bottom of the sea, and the female is regarded by the Malays as typical of maternal affection; they declare that the offspring of the dugong shed tears which attract the mother to her young, and these tears are eagerly pur-

chased and jealously preserved by the superstitious as a charm for securing the affections of those whom they love.



Head of the Eel.

In the Eel and other serpentiform fishes we perceive a special contrivance for protecting their small round eye, in the form of a transparent convex horny shield, which passes before the eye without obstructing the sight. In some species this shield is movable, in others not. Such an organ is of great utility, and affords not only comfort and convenience, but is essential to the preservation of the eyes of animals that burrow and immure themselves in mud and harsh sand, often at a depth of fourteen or sixteen inches, in search of food.

In the eye of the Mud-Crab we meet with an expedient which is not only novel, but almost, if not altogether, unique, and even more curious than the one just cited. The usual

haunts of the mud-crab are similar to those of the eel tribe. It grovels in beds of sand, loose soil, mud, and shallow, turbid water, with which its eyes are so besmeared that they would be unavailable for the purpose of vision were it not that the Creator has anticipated this little creature's wants, and furnished it with a tuft of hair, situated above the eye, "to which the prominent horny eye can be raised, and against which it is wiped with an action as intelligible as that of a man wiping his spectacles," and thus the eye is fitted for its office by having the means of keeping the surface of the cornea clear and transparent. A somewhat analogous provision exists, though in a less developed form, in the Crayfish, which exercises its burrowing propensities in the banks of rivers and obscure depths of water, where it finds a favourable and secure retreat from the attacks of its enemies.

One of the most singular modifications of the eye in vertebrate animals is found in the Anableps, or four-eyed fish, a denizen of the rivers of Surinam. At the first glance this fish appears endowed with four distinct eyes, and naturalists have had much difficulty in unravelling their intricate mechanism. Each eye

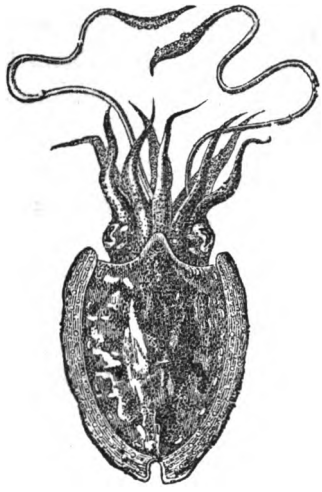
is supplied with a retina, vitreous humour, a single crystalline lens, two cornæ, formed by an opaque band crossing the eye transversely, and an iris or coloured portion which sends out two cords that meet each other under the transverse band, so that the fish appears to possess a double pupil. Some authorities are of opinion

Anableps, or Four-Eyed Fish.

that the object of this peculiar structure and formation is to enable the animal to perceive near and distant objects simultaneously, thus, while the two lower eyes are engaged in quest of worms, the two upper eyes, which are the largest, are employed for self-preservation, and, like vigilant sentinels, instantly warn it of the slightest approach of danger, and defend it from the insidious attacks of the larger fishes.

The large fierce-looking eyes of Cuttle-fish, which belong to the invertebrate class of animals, and the highest class of mollusca, are very similar to those of ordinary fishes,

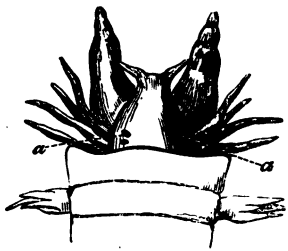
except that the cornea is positively absent or reduced to the smallest proportions, being mere annulets through which the crystalline



Cuttle-Fish.

lens may be seen protruding. The Acephala or bivalve mollusks, *e.g.*, the cockle, mussel, and oyster, do not generally possess eyes; yet the Gasteropoda or inhabitants of single shells have sometimes four black eyes situated at the extremities of their tentacles or horns. The lowest, most simple, and nearest approach to

visual organs are met with in the "*eye-dots*" of the medusa, thorny oysters, scallops, and star-fish. In the latter they are very rudimentary, constituting a bright red speck, at the extremity of each ray. Each is supplied with a fine delicate filament of nerve, from the nervous ring which encircles the mouth. In the thorny oysters the eye-specks stud the edges of the mantle, while in the scallops they are situated at the base of the mantle, and on the margins of the mouth. The earliest unmistakable



Head of the Nereis.
aa, the Eye-dots.

A, the Eye-dot entire.
B, Part of the choroid coat removed, to show the eye with the optic nerve.

signs of special organs of sight are the *ocelli* of the annelida, or worms; which in form are not unlike minute globular beads, their number and disposition varying in the different classes. The eyes of the argonauta

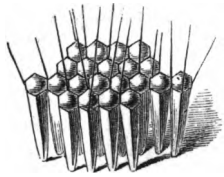
are of large size and development. Those "mimic ships," the fragile nautili, have four eyes, situated upon tentacles or thread-like feelers; periwinkles are endowed with eyes; auger-shells are believed by some writers to possess eyes which are extremely minute and rudimentary, and are placed on tentacles, while in some species there is not a trace of them discernible. In the genus Nassa, the eyes can be seen on the middle of the tentacles. The pedunculated eyes of strombs or wing-shells are large and well developed. The infusoria, which are among the smallest of animated atoms, and of microscopic minuteness, are believed by some zoologists to possess rudimentary eyes. That lowly-organised and frail class of beings termed Zoophytes are not endowed with ordinary eyes, yet frequent experiments have most satisfactorily demonstrated that they have an organisation which renders them sensitive to the presence of light. Zoophyte is a name given to the lowest class of animals which appears to constitute an intermediate link between animal and vegetable existences. Many animals, it is believed, have conferred upon them a distinct sense without

possessing a corresponding distinct organ for its exercise, and it is considered highly probable that these senses are continuous or distributed over the whole surface of the body, like that of touch.

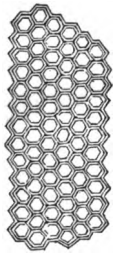
> "Nature to all, without profusion, kind,
> The proper organs, proper powers assign'd,
> All in exact proportion to the state;
> Nothing to add, and nothing to abate."
>
> POPE.

The simple eyes of Insects are two in number, and similar to those of animals in a much higher scale of existence, and are commonly placed on each side of the head; but the compound eyes of insects are full of wondrous interest. In their variety and beauty of organisation, number, and distribution, they certainly constitute one of the marvels of the insect world. The surfaces of the compound eyes, when examined under the microscope, appear intersected in such a manner as to form a vast number of separate six-sided convex facets, resembling lattice-work, and from their intermediate spaces minute silken hairs arise, designed to preserve the eye from injury. In some shell-fish and in a few insects, as, for

instance, moths, the facets are quadrangular in form. Each facet or eyelet is seen to constitute the surface of a separate eye, pro-



Group of Prismatic Facets, from the Eye of a Bee.

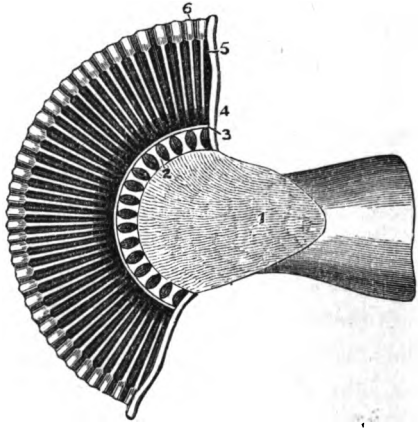


Six-sided Facets from the Eye of a Cockchafer.

Square Facets from the Eye of a Moth.

tected by a cornea or window. Each little eye is provided with a distinct crystalline lens, the inner points of which are coated with a layer of black mucous pigment, and each is furnished with a distinct branch of the optic nerve. Most insects have compound eyes conferred

upon them; very many possess in addition to the compound, two or three minute simple eyes, which are called *ocelli, stemmata,* or eye-dots, and are for the most part smaller, without facets, and are usually situated in front of



Section of the Eye of the Cockchafer.

1, Optic nerve and its branches; 2, 3, Retina; 4, Pigmentum nigrum; 5, Thread-like nerves given off from the retina; 6, Corneal facets or double convex lenses.

the head; in some insects they are of unequal size. Some of the Saüba or Parasol Ants *(Œcodoma cephalotes)*, of tropical America, differ from every other kind of ant, in having, besides lateral compound eyes, a twin ocellus

or simple eye located in the centre of the forehead. The number of eyelets in the compound eyes is exceedingly variable. The ant owns 50, while the ant-lion has six compound eyes on each side of its head. In the two eyes of the drone-bee there are 1,400. The working bee has, in addition to three large simple eyes, situated on the crown of the head, 3,500 smaller ones; in the common house-fly 8,000 have been counted; in the beetle, 6,362; in the horse-fly, 7,000; in the cockchafer, 8,820; in each eye of the dragon-fly 13,500 exist; in the silk-moth, 6,236; goat moth, 11,300; hawk-moth, 20,000; mordella (a species of beetle), 25,088; and in some of the butterflies their exuberance is almost incredible, 60,000 having been enumerated.

Of all the insect tribe, the beautiful, pearly blue-gray eyes of the dragon-fly (*Libellula vulgata*) are the largest, while in a genus of ants called *Pseudomyrma*, they are so capacious as to occupy nearly the whole of each side of the head. The structure and optical powers of some insects are exceedingly feeble and rudimentary, and of almost infinitesimal size; indeed they can only be rendered obvious

by means of the microscope; while others, again, are entirely destitute of eyes, yet are very sensitive to light; *e.g.*, a parasite recently discovered on the hive-bee *(Braula Cæca)*, the Termites or White Ants of Southern America, the formidable and destructive Driver Ants of Western Africa, and the genus *Polydesmus* and some others.

The eyes of insects assume a vast variety of forms. In some they are spherical and in others notched. The diminutive eyes of the

Eye of a Beetle.

Foraging Ant *(Eciton drepanophora)* of tropical America are oval and convex, but do not present the usual six-sided compound lenses common in other insects. In the family of insects, *Crabronidæ* or wood-wasps, they are for the most part oval, though occasionally notched or kidney-shaped. In the family of

insects, termed *Sapygidæ*, hornets, and longicorn beetles, the eyes are generally notched. In the genus *Gyrinus*, or whirligig beetles, a fine narrow corneus band traverses each eye, at such a depth as to give to the insect the appearance of having two eyes on each side the head. The eyes of nearly all insects are immovable, which apparent deficiency is undoubtedly more than recompensed by their number and arrangement. They are usually sessile, though occasionally situated on tubular peduncles, and in some few instances are set in little pits or depressions, and do not project above the surface of the head. The images formed on the retina in compound eyes are not inverted, as in simple eyes, but are erect. The compound eyes are adapted for seeing distant objects, and the simple for near ones. The vision of wasps is superior to that of bees. The resplendent and vivid hues of colour which alternately flash from the eyes of the insect creation are often so marvellously brilliant that they cannot fail to attract and interest even the most superficial observer. In some the eyes are illuminated with colours of purple and gold; in others, as, for example, the harvest-

flies, and many water-fleas, they are red or of a crimson hue, and sparkle like rubies; and in the bee, *Saropoda*, they glisten like opals; while in others, again, the eyelets resemble a luminous coronet of diamonds, encircled by a most gorgeous halo of burnished gold. The handsome black and white spotted winged Celery Fly (*Tephritis onopordinis*), whose injurious practices on the celery and parsnip plants are well known, has green eyes. In a kind of beetle peculiar to the West Indies and the Silver Streak Butterfly (*Argynnis Paphia*) they are of a brilliant emerald-green, the former emitting two streams of intense pure green living light from eyes implanted at the back of the head.

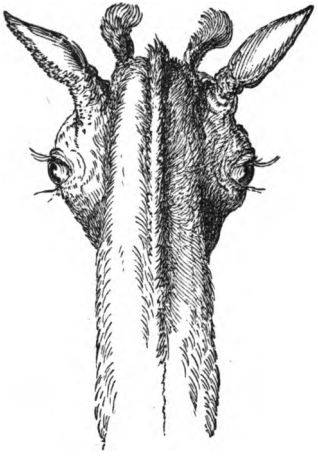
With this knowledge of the peculiar structure of the eyes of insects, we cannot wonder that such beautiful winged creatures as the butterfly and the little bee, ever on the alert, and possessing thousands of perfect organs of vision, varying both in power and range, should in our childhood have made their chase so arduous, as they flitted to and fro in the mid-day sunshine; neither can we wonder at the bee's power to rise high in the air and instinctively

pursue a direct course to some distant bed of flowers, and, after gathering a store of nectar, steer its course through the pathless air, with unerring precision, back to its own hive.

Let us for a moment look at the *position* of the organs of vision in the different classes of animals, and we shall find they are disposed in a manner most suitable to their nature and the varied spheres of action to which they have been assigned by their Maker.

In Man and Monkeys the eyes are favourably situated for observation, being immediately under the forehead, and directed well forward; in the former they are proportionately in closer proximity than in any other known animal. In the lower ranks of the mammalia, for instance, in the graceful Deer, the gentle, timorous Hare and Rabbit, the eyes, which are soft and mild in their expression, are situated on the sides of the head, and are usually advanced and well-developed, by which means their range of vision becomes greatly enlarged, and is well adapted to protect them from their numerous enemies. Hares have been known to run unconsciously between the legs of a man, and even against a wall, when hard

pressed by dogs; this has undoubtedly arisen from being blinded by fear, and having their eyes turned backwards, looking out for their enemies in the rear. That elegant and tallest



Eyes of the Giraffe.

of quadrupeds, the Giraffe, is a native of Abyssinia and Central Africa; its giant neck presents to the zoologist and comparative anatomist one of the most singular modifications of structure. This animal has its large brilliant orbs placed laterally, and so prominent that it can command a more extended range

of vision than any other mammalian. Moreover, its vigilance and sagacity present difficulties almost insurmountable to its pursuers, who rarely can approach within rifle-shot, for, as the sketch plainly shows, the animal is actually as competent to survey objects behind it as before.

The eyes of the Horse are also placed laterally, and so far forward as to enable him to recognise his enemies at a great distance, and to guard more readily against the danger of surprise, as he bounds over the plains, or when pursued by his stealthy foes, the large carnivora, being enabled to perceive them before they can spring upon him. It is a well-known fact to almost every one who is at all conversant with the usages of the horse, that often as soon as the whip is raised, even before it descends on his back, he twinges, and at once his speed becomes accelerated, affording an incontestable proof that the animal can see behind him.

In Dogs the eyes are for the most part seated in the front of the head, and have a forward direction, while in the Wolf, Fox, and some other animals they present an oblique position.

The eyes of Bats, although not large, are generally well-developed; yet in some they are so minute and feebly organised as to impart to them the appearance of blindness, a fact which has undoubtedly given origin to the popular and often applied simile — "as blind as a bat,"—a circumstance, too, which did not fail to attract the attention of the poet Collins, and to which he has adverted in the following lines:—

> "Now air is hush'd, save where the weak-eyed bat,
> With short, shrill shriek, flits by on leathern wing."

In the Long-eared Bats the eyes are so small as to be scarcely discernible, but they are very conspicuous in the mouse-coloured kind. The eyes of some bats differ from those of other nocturnal animals in being extremely diminutive, particularly the Particoloured Bat and the Barbastelle. In the latter they are situated at the base of the ears, and often escape common observation, being veiled by their long, soft mouse-coloured fur. The imperfect vision of bats is abundantly counterbalanced by the exquisite delicacy of sensation conferred upon their membranous wings, which serve to direct

the animals in their nocturnal flights and movements. The celebrated naturalist and eminent physiologist, Spallanzani, found, from a series of interesting but cruel experiments, that bats whose eyes had been wholly obliterated, could fly through small apertures with as great precision as those possessing perfect organs of vision.

In the common Mole, as we have already stated, the eyes are very minute. These small shining black globules lie deep in the skull, and are usually invisible, being completely hidden by its short velvety fur; a condition most advantageous to an animal designed by nature to pass its existence principally beneath the earth's surface; and, again, it is particularly favourable to it in its mining operations, when excavating its dark subterranean labyrinths. The descriptions which have at different periods been published relative to the organs of sight in the mole have been very varied and conflicting. The popular traditional notions so long entertained by our ancestors relative to the imperfect optical powers of the mole have not been quite

destitute of some foundation in truth, to which allusion has been made by our great bard, Shakspeare,—

> "Tread softly, that the blind mole may not
> Hear a footfall; *we now are near his cell.*"

The recent investigations made by Dr. R. J. Lee, and published by the Royal Society, seem to confirm the foregoing opinion. We learn that "the eye of the mole presents us with an instance of an organ which is rudimentary, not by the retention of fœtal characters,—or, to use a better term, 'arrest of development'—but through *disuse*, 'aided, perhaps, by natural selection;' for, as Mr. Darwin has shown to be the case with the Tucu-tuco (*Ctenomys*), a South American burrowing rodent, subterranean mammals are liable to inflammation of the nictitating membrane, or third eyelid—a condition by no means favourable to the combatant in the 'struggle for existence.'"* The tucu-tuco is so designated in imitation of the very peculiar and characteristic sound which it emits when beneath the ground. As if to recom-

* Vide *The Lancet*, July 9th, 1870.

pense for the defect of vision in the mole, we have presented to us a beautiful principle of compensation; the senses of hearing and smelling being much more highly developed than in many other creatures. The former sense is extremely acute in this animal.

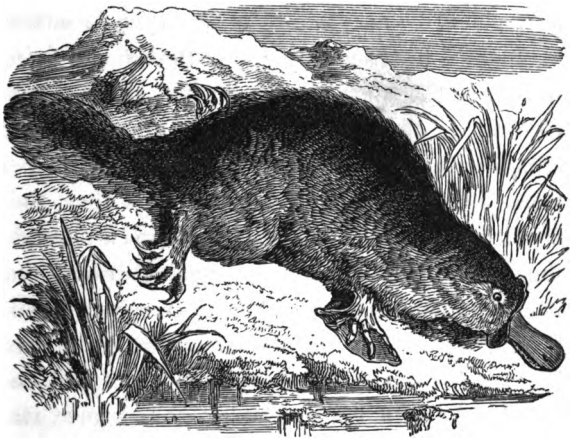
> "Dark night, that from the eye his function takes,
> The ear more quick of apprehension makes;
> Wherein it doth impair the seeing sense,
> It pays the hearing double recompense."

In the male Babyroussa, or Indian Hog, a rare and striking peculiarity exists. Two enormous semi-circular canine tusks, more than half a yard in length, arise from the upper jaw, and, perforating the upper lip, turn up in front of the eyes, obviously affording those organs a strong and most efficient protection when the animal courses through the thickets. According to Archdeacon Paley, "the animal sleeps standing, and, in order to support its head, hooks its upper tusks upon the branches of trees." This opinion, however, is regarded by some modern naturalists as not only doubtful but as fanciful and gratuitous; while others, again, think it not improbable that the animal has recourse to its tusks for hooking down the

upper branches of the banana and other trees, upon the leaves and buds of which it feeds; yet very considerable difference of opinion relative to the various purposes these tusks are designed to serve in the animal's economy has long existed, which has naturally given rise to a good deal of wild conjecture and discussion to account for them; all of which is unsupported by any well-authenticated observations. A somewhat similar provision is seen in the two antennæ, or horns, fixed in the heads of bees, and the minute hairs which arise from the surface of the eyes of some butterflies and other insects, forming sensitive shields, which apprise them of danger and effectually preserve their eyes from injury and destruction.

Amongst the order Edentata, or toothless animals, we may mention the Ornithorhynchus Paradoxus, whose type of structure may be justly deemed an anomaly in creation. It is peculiar to Murrumbidgi and other rivers in South-eastern Australia, and is called by the English the Duck-Bill, and by the colonists the Water-Mole, on account of its habits and burrowing propensities. Sidney Smith describes

it as "a quadruped as big as a large cat, with the eyes, colour, and skin of a mole, and the bill and web-feet of a duck." Its general appearance and physiognomy is certainly the strangest in the whole domain of organised beings, "it is an eccentric sort of bird bitten with the am-



Ornithorhynchus Paradoxus.

bition to be considered a quadruped." It inhabits both land and water, for which it is peculiarly adapted, swimming and diving with the greatest facility. It burrows in the banks of rivers, forming tunnels of some complexity

to a distance of more than thirty feet, at the extremity of which it forms a suitable domicile of dry grass and weeds, in which it rears its young. The eyes of these creatures are imperceptible at birth, and in the full grown animal they are very small and brilliant, and are, by the way, defended by a curious leathern appendage. The position of the eyes is admirably suited to the aquatic life of the animal, being implanted high on the head; yet their powers of vision, when on the land, are somewhat circumscribed. Dr. Bennett, who captured a male and two young ones, tells us that they could not perceive objects well in a straight line, consequently they ran against everything in the room, and upset whatever was easily overturned. The first specimen which arrived in this country was received by zoologists and naturalists with grave suspicion, and gave rise to much speculation and many ingenious theories to account for the very peculiar and puzzling nature of the animal's beak, while others discredited the fact of its being a *bonâ fide* appendage, but the reality of the fact was subsequently fully established by Sir Henry Halford.

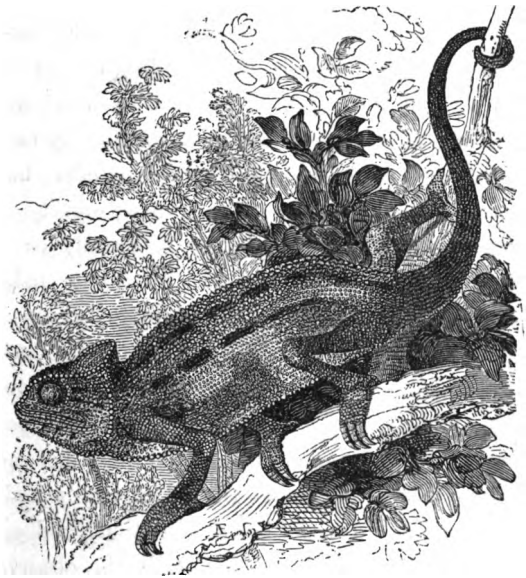
Usually the eyes of Birds are so advantageously disposed that they can, without obstruction, command a very wide extent of horizon. In some they are very large, and have a considerable resemblance to those of fishes, in being more or less depressed in front, and possessing but slight power of motion. To remedy this, they frequently turn the head, to extend the field of vision, as is observed in pigeons and fowls. In the nocturnal birds of prey their situation is such as to enable them to see almost directly forward, and in the diurnal hawks, eagles, vultures, falcons, and buzzards they are placed laterally; while in the ostrich they are so finely adjusted as to allow of the bird's seeing, at the same time, with both eyes, the same object, and it is said that its eyes more nearly resemble those of a man than those of a bird.

The brilliant and immovable eyes of those dreaded and destructive reptiles, the Serpents, are most wisely and beneficially adapted to their appointed mode of life, being seated either laterally, and having an upward and forward direction, as in the true boa constrictor, the rock snake of India, the puff-

adder, the sea serpents, and the viperine serpents; or they are placed upon the upper surface of the head, as in the water serpents, the burrowing snakes, the coral snake, and the venomous colubriform serpents; conditions which enable them to comprehend an ample lateral, forward, backward, or upward view.

The Chameleon is a lizard-like reptile, found in India, Africa, and in many other parts of the world, and although its general appearance is by no means prepossessing, nevertheless, its singularly interesting property of changing colour has in every age been a source of curious interest to poets, whilst the *modus operandi* of this phenomenon has been involved in a considerable degree of obscurity, and still continues to perplex and excite the ingenuity of the philosophical zoologist. It is stated that "the *rete mucosum*, or coloured layer of the skin, contains two kinds of pigment, situated in different layers; the deeper-seated layer is of a deep-green or violet-red colour, the superficial pigment is of a greyish colour; the deep-seated pigment is contained in branched cavities, and is movable, producing by its partial accumulation and varying proportions

with the superficial layer, the changes of colour for which the chameleon has in all ages been remarkable." The neck of the chameleon is immovable, and in order to compensate for



The Chameleon.

this, the eye is exceedingly prominent and conspicuous, the ball projects considerably out of the skull and is constantly defended by a single eyelid, which is but a continuation of

the skin which covers the animal's head; it is perforated by a small dilatable circular aperture, corresponding with the pupil, over which the animal has full control. This creature is endowed with the peculiar faculty of being able to move its eyes independently of each other, which imparts to it a very grotesque appearance. It can move one eye upwards, while with the other it can look down upon the ground, and can perceive simultaneously objects both before and behind. This rare property of being able to move the eyes separately exists also in the sea-horse and in some fishes (*Gobies*), which possess considerable power in elevating the eyeballs from their orbital cavities; and it has been observed also in some hares, rabbits, and birds whose eyes are very convex. So little reciprocation is there between the two lateral halves of the chameleon's body, that there is no accordance of action, and not infrequently one half of the body is observed to be asleep, and of one colour, while the other is extremely vivacious in its movements, and exhibits quite a different hue. From the same cause arises the animal's inability to swim. The tongue of the chameleon is a most

wonderful instrument; it is a long hollow tube, with a bulbous trumpet-shaped extremity, smeared with a viscid saliva, and is the only part of the animal's body which moves with quickness; it can be withdrawn into the throat with marvellous rapidity, and folded up like a telescope, or darted forth like lightning, with such unerring precision that an acute observer who kept many of these animals, "never knew a chameleon miss his mark but once, and then the fly was on the other side the glass." The chameleon is one of the most striking instances of an animal possessing the extraordinary property of assuming to some extent the various colours of the foliage and rocks, &c., by which it may happen to be surrounded, and thus escape observation. This property, however, is not exclusively enjoyed by the chameleon; it is scarcely less remarkable in the genus *Anolis*, peculiar to America, the *Agama*, a genus and family of saurian reptiles found in South America; and the famocantrata or fringed gecko, met with in Madagascar, and some others, can elude detection by a remarkable chameleon-like faculty of changing their colour. A returned missionary from India informed the writer that

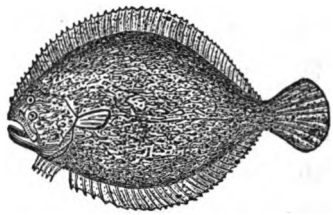
when resident in that country he kept a chameleon and a monkey, whose habits and society contributed largely to his diversion, and that, notwithstanding the rare faculty of changing colour possessed by the chameleon, and the great amount of circumspection exercised, it was unable to secure itself against the savage assaults of the monkey, by which it was not only mortally wounded, but the monkey banqueted upon the mangled remains of the chameleon.

The wisdom displayed in the diversity of colour in different animals is an indisputable evidence of Divine foresight and regard for their safety and well-being. All animals are normally attired in that dress which is most suitable to their respective conditions and habitations. The elegance of form bestowed upon even the most pernicious animals is especially designed by Providence, and is of intrinsic worth, although often too little esteemed. If it were not foreign to the present treatise, instances almost innumerable might be adduced relative to the disguises of animals, and the cunning they evince, as well as the wonderful way in which the vast hosts of birds,

beasts, reptiles, and insects are made to harmonize with the richly diversified hues of foliage amongst which they live; and how, in some instances, animals, when under the excitement of fear, or when persecuted, feign lameness; and at other times, as if to render the deception more complete, simulate death, and patiently submit to the indignities too often inflicted upon them. Some fishes resemble the sands, mud, and water in which they live, and so escape injury and avoid capture; while others, again, resort to the most ingenious stratagems to evade detection. But we must hasten back to the beaten track; our limited space compels us to desist from enlarging upon this very instructive and interesting subject.

The position and direction of the eyes of Fishes exhibit considerable diversity; in some they are closely approximated, while in others they are placed far asunder; in some they are situated laterally, while in others, as the angler or sea-devil, the uranoscopians or star-gazers, and in whales, they are located on the upper aspect of the head, so as to allow of the animals seeing in almost all directions. In

sharks and rays the position of the organs of vision are varied in the different species, and are set on movable cartilaginous footstalks, articulated at the lowest part of the orbit, thereby admitting of a greater extent of motion.

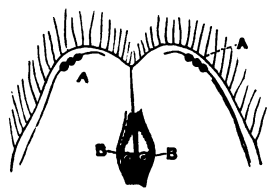


The Flat-Fish.

In the family of Flat-Fish (*Pleuronectes*) we may specify, as a familiar instance, the turbot and flounder tribe, in which both eyes undergo a slight translation, being located on the same side of the head, on the upper or coloured side of the fish, while the cornea, or little window, is nearly flat, for a prominent eye would have been very inconvenient. Again, flat-fish "are not constituted to swim in the same way as other fishes, *i.e.*, with the back uppermost, but lying upon one side;" and in this most obvious peculiarity there is a singular and re-

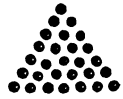
markable deviation from the ordinary type, which is very observable in the foregoing sketch. Near the head, the spine is seen to assume a somewhat abrupt turn to the dark-coloured surface of the animal, imparting to it a distorted appearance.

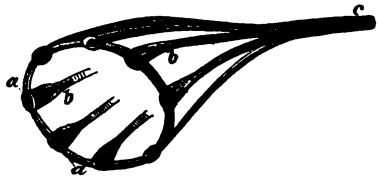
The eyes of the varied tribes of Insects are very differently disposed. In the common bee three simple eyes are situated on the crown or front of the head, and in the bees of the genus *Prosopis* they are arranged in a triangle. In the scorpion, whose sight is very acute, three small immovable simple eyes are met with on each side of the anterior part of the head. These are represented at A in the accompanying figure, and behind these, near the centre of the head, at B, an eye of much greater size is



situated. The silkworm and the caterpillar possess simple eyes; the eyes of the former are

twelve in number, and of the latter eight, disposed in a perfect circle; while those of the common millepede (*julus terrestris*) are simple, and twenty-eight in number, being disposed in seven rows, as shown in the sketch.

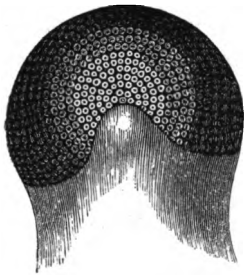




Eye of the Caterpillar.
aa, the eye-dots; *bb*, branch of optic nerve supplied to each eye-dot; *c*, the common trunk of nerve.

The eyes of the Crustacea or Shell-Fish, such as the shrimp, crab, lobster, &c., are usually two in number, though sometimes four, and occasionally they are aggregated together in one place, and are either simple or compound. Sometimes both kinds are found on the same animal, in one group, and are sessile, resembling those of insects. In the lobster, cray-fish, and shrimp, the facets are not hexagonal, but quadrangular in form. In some creatures these eyes are placed upon movable

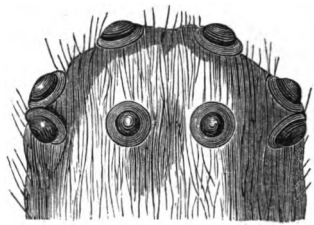
peduncles, while in others the peduncles are fixed. In the two compound eyes of the lobster there are about 5,000 eyelets, stilted out on the extremities of long movable peduncles, which the animal can project or retract and conceal at pleasure, or which, by means of movable joints, can be turned down into depressed receptacles to suit its convenience. It is a remarkable fact that a considerable number of one order of crustaceans (*Branchiopoda*) possess but a single central compound eye, from which circumstance they have been termed *Monoculus*, resembling, therefore, in this particular the Homeric fabled race of giants, the Cyclops.



Eye of the Shrimp.

All the Arachnida or Spider tribes are furnished with simple eyes, which are fixed, and vary much in size and number, from two to ten, and are differently disposed over the various parts of the body in the different genera. They are often of a sapphirine colour,

sometimes of a bright amber, while the pupil is seen as red as a ruby. When examined by the aid of a microscope they appear transparent, and sparkle like diamonds, the creature seeming literally crowned with a blaze of jewels, presenting a most enrapturing spectacle, which in no small degree atones for the otherwise hideous and really repulsive aspect of



Spider's Head, showing the form and position of the Eyes.

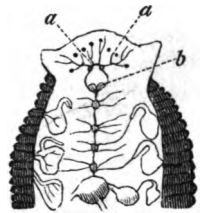
the insect. The sense of sight in most of the spider species is so exquisite as to be considered superior to any of the other articulated classes, and of all insects spiders are certainly the most sensitive, vigilant, and cunning; for, while they peer through a hole in their fine and delicate filmy web with one luminous point, they can watch their struggling, terror-stricken prey entangled in their silken fetters with another.

The eyes of the poor and seemingly insignificant Snail tribe are simple and well developed, and offer striking instances of effectual adaptation for their protection and

Helix aspersa—Common Garden Snail.
The specimen figured here represents a left-handed shell, which is one of the rarest and most beautiful of the race.

convenience. In those which dwell upon dry land, and in the slug also, the eyes are mounted on the summits of their long upper pair of cylindrical tentacula or horns, which they can by volition retract and hide within their heads, or thrust out in pursuit of

food and distant objects. In others they are stationed on the horns, near the middle; and in others, again, such, for instance, as the fresh-water and the marine group of snails,



Anterior part of the Common Leech.
aa, the eye-dots; *b*, the mouth of the leech.

they are sessile at the base. Among the *Suctorial Annelida*, or Worms provided with mouths for sucking, the common leech, whose peculiar instinct for sucking blood has proved such an invaluable means for alleviating human suffering, owns ten small, simple, slightly prominent globular eyes (ocelli) disposed in a semi-circle on the anterior part of the head, directly over the mouth. In very many of the annelides the eyes are obsolete. That truly strange little worm, the *Polyophthalmus*, *i.e.*, many-eyed, has conferred upon every segment of its body

a pair of brilliant jet-black eyes; while a somewhat diminutive annelid presents us with a still more remarkable anomaly, namely, that of actually carrying its eyes in its tail.

——"each moss,
Each shell, each crawling insect, holds a rank
Important in the plan of Him who framed
This scale of beings; holds a rank which lost
Would break the chain, and leave behind a gap
Which Nature's self would rue."

THOMSON.

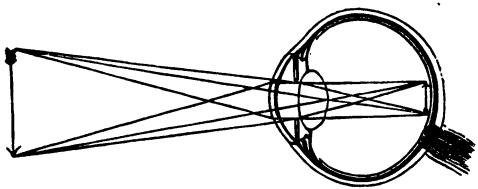
If we attentively survey in detail the numerous important modifications in the structure of the eyes of animals, we shall find that one general design prevails, which is varied conformably to the diversified conditions of life presented by each specimen or class; moreover, this will aid us in forming a more accurate conception of the marvellous attributes of our own organs, which are but a modification of the "one common pattern" which pervades all vertebrate animals.

CHAPTER III.

THE FUNCTION OF VISION—RETENTION OF VISUAL SENSATIONS IN HEALTH AND DISEASE—COLOUR-BLINDNESS—ABSENCE OF VISION IN CERTAIN ANIMALS—DEVELOPMENT OF SIGHT IN MAN AND IN THE LOWER ANIMALS.

In order to explain or comprehend the wonders of the function of vision, we must again review the innermost tunic of the eye, called the retina, which has been described at page 19 as consisting of threads of the optic nerve most exquisitely wrought into a beautifully delicate network, constituting the seat of vision. Rays of light emanating from a rare and travelling into a denser medium are refracted or bent from a direct course; for instance, rays of light passing from an arrow, as delineated below, and impinging on the various structures of the eye, undergo four variable

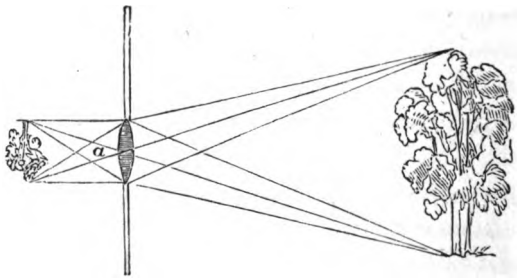
processes of refraction, by the cornea, the aqueous humour, the crystalline lens, and the vitreous humour, and finally converge to a point on the nervous expansion, termed the retina, upon which all images of external objects are depicted in an inverted direction, and thence transmitted to the brain through the medium of the optic nerves, and rendered perceptible to the senses.



This phenomenon can be readily demonstrated on the fresh eye of an ox, by carefully dissecting away from its posterior surface a portion of the sclerotic and choroid coats, so as to reveal the retina. If the cornea be then turned towards a lighted candle, on looking through from the back of the eye, an inverted image of the same will be seen on the retina. The same may be further illustrated on the

eye of an albino, for example, on the eye of a white rabbit, without even dissecting away the sclerotic or outer coat.

The subjoined figure, which may be considered to represent a lens, marked *a*, placed in an aperture in the window-shutter of a darkened room, will aid us in illustrating our



meaning. All the rays of light issuing from each point of the tree and proceeding towards the lens are united into a focus behind it, which can be proved to ocular demonstration by holding a sheet of white paper so as to receive the rays of light, when an inverted picture of the tree will be seen upon it. The inversion of the picture is occasioned by the rays of light proceeding from the upper part

of the tree, after passing through the lens, falling upon the lower part of the paper, while the rays coming from the lower part of the tree, after being transmitted through the lens, are refracted on the upper part of the paper, and in like manner the rays emanating from the intermediate surfaces of the tree.

The images of objects presented to the human eye are said to be depicted on the retina, yet, after all, these expressions are but figurative, for in reality we see no image or picture whatever on the retina, "but the object itself, and as we see the parts of an object in the direction of the rays proceeding from them, it follows that the eye truly sees objects in their natural and relative situation." As Dr. W. B. Carpenter has justly remarked, "It is the mind which rectifies the inversion; and it is just as difficult to understand how the inverted image on the retina should be taken cognisance of by the mind at all, as it is to comprehend how it should be thus rectified."

To extend these remarks beyond this brief and simple description of the function of vision, or to venture upon detailed physiological descriptions of the many learned and very ingenious

theories which have from time to time been advanced, would far exceed our prescribed limits, and might not be deemed popular; moreover, the unrevealed link in the grand chain which connects matter and mind is and for ever must remain veiled from our finite understanding, for "it is the glory of God to conceal a thing;" "great things doeth He which we cannot comprehend."

The fact that visual sensations are retained in the mind for a brief period after the impressions which originated them have disappeared, is familiar to almost every one. What in common phraseology is called a falling star presents the appearance of a ribbon of vivid light. The same is frequently illustrated in numerous pyrotechnical displays; for example, the Catherine wheel in its rapid rotatory process forms an apparent circular band of fire; *i.e.*, the burning object on passing rapidly round produces a new impression upon the retina ere the sensation effected by the previous one has vanished, hence the appearance of continuity in the light, constituting the optical illusion. In health, the retention of sensations by the retina, after the impression

has passed away, is estimated at about one-third of a second. This phenomenon not only aids us in the act of vision, but enables us to retain the perception of an object after the agent that produced it has disappeared.

Of all the organs of sense, the eye is the most subject to deception. In individuals suffering from ill-health, who are mentally and physically enfeebled, also in some morbid conditions of the retina, there is a preternatural susceptibility to impressions, and the power of imagination becomes unnaturally sensitive. Under such circumstances impressions are too vivid, and are retained for a longer time than usual, and have often proved a fertile source of spectral illusions. Very considerable difference exists in the aptitude wherewith men distinguish colours, all of whom may be considered to be endowed with ordinary sight. This subject has long been of deep interest to the philosopher as well as to the physiologist; neither has it escaped the attention of the phrenologist. While some individuals are capable of discriminating with surprising quickness every gradation of colour, others have the misfortune to suffer from that peculiarity of

vision termed colour-blindness, which consists of an incapability of distinguishing colours. The seat of this defect is referable to the cerebral portion of the visual organ. The science of colour, although essentially mental, is intimately connected with the physical sciences of optics and physiology. In some cases of colour-blindness, blue can be distinguished but not red; in others red but not blue; in others, again, red is seen as black, and in others as drab. The eminent chemist, John Dalton, suffered from the last-named defect. The late Dugald Stewart is said to have confounded green with scarlet; a scarlet Siberian crab, and the green leaves by which it was surrounded, did not present to him the least difference of colour, yet he could perceive perfectly the difference in size and shape. Some individuals personally known to the writer have been partially so circumstanced, but, by exercise and great attention, have conquered the defect. A cotton manufacturer, who suffered from this imperfection, confounded green with red; a red fuchsia in full bloom having on one occasion been brought into the room, he exclaimed, "How beautifully green the flowers are!" On inquiry it was found

that his father suffered from a similar affection. Colour-blindness is in some instances undoubtedly transmitted from the parents to their offspring, and may, therefore, be regarded as an hereditary defect of vision. Phrenologists aver that the judgment of colour is located in a special organ, which is remarkably full and conspicuous, particularly so in painters who are eminent in their art. Dr. Gall, the founder and zealous promulgator of the system of Craniology now designated Phrenology, has affirmed that where the judgment of distinguishing colours is defective, a local deficiency of brain is discernible. At this we cannot wonder, if we consider Dr. Gall's fundamental propositions, that the brain is the organ of all the propensities, sentiments, and faculties, that it is composed of as many particular organs as there are propensities, sentiments, and faculties, and that the manifestation of these is determined by the development or organisation of the brain.

By far the greater portion of red-blooded animals are furnished with eyes, yet instances occur of extraordinary departures from this common law; for example, in the golden mole

(*Talpa Asiatica*), the slepez (*Spalax typhlus*) or blind mole-rat, whose eyes are extremely minute and lie concealed within their soft, velvety covering, and, according to Mr. Broderib, "though it cannot see, it lifts its head in a menacing attitude towards its assailant, and, when irritated, snorts and gnashes its teeth, but emits no cry." Numerous other illustrative examples might be adduced, amongst them, certain moles, in addition to the one just named; also, the family of blind lizards, a few reptilia discovered in the marshes of Carolina, a genus of fishes of the eel tribe (*Muræniдæ*), and the hag-fish, and some other fishes named *Glanidians*, thrown out sometimes by thousands in the turbid and smoking waters issuing from the neighbourhood of the South American volcanoes. An anatomical preparation of a specimen of the blind fish, from the Mammoth Cave of Kentucky, prepared by Drs. Barker and Mapother, is now exhibited in the Museum of the College of Surgeons, Dublin. Lastly, we may mention the singular snake-like proteus (*Proteus Anguinus*). Sir Humphrey Davy discovered a number of these curious fish in the grotto of

the Maddalena, at Adelsburg, in the Duchy of Carniola, at a depth of several hundred feet. They also inhabit the brackish waters of other great caverns in Austria, whose dark and fathomless recesses are never illumined by the sun's rays. To accord sight to animals inhabiting such dark abodes would be superfluous, hence these strange creatures in being blind resemble insects and other animals which perpetually dwell in subterranean retreats.

The extreme slowness with which the faculty of sight is acquired and practically realised in the human subject, when compared with its early maturity in many of the inferior animals, has been a matter of surprise and frequent comment. The truth of this has repeatedly been fully confirmed by the experience of persons who have been born blind, and acquired the function of sight in mature life. With regard to the progeny of many of the inferior animals, it must be remembered that they are often abandoned at a very early period by their parents, and thereby become almost wholly dependent upon their own sagacity and exertions for subsistence, consequently early de-

velopment of the eyes and function of sight in their case is indispensably requisite for their support and security—

> "Hale are their young, from human frailties freed,
> Walk unsustained, and unsupported feed,
> They live *at once*,—forsake the dam's warm side—
> Take the wide world, with nature for their guide,—
> Bound o'er the lawn, or seek the distant glade,
> And find a home in each delightful shade."
>
> YOUNG.

Among domestic animals, the sight of the calf, colt, and lamb is very early developed; while the offspring of wild beasts are, for the most part, born blind, and acquire their sight more slowly. The eyes of the cubs of the Virginian opossum are singularly minute, and do not usually open until about the fiftieth day. According to Sir Humphrey Davy, young crocodiles and turtles, which are hatched by the heat of the sun's rays, immediately, by an unerring instinct, betake themselves to the water; this is also the case with the gosling and duckling, even when hatched by the domestic hen. The crocodile has been known to assume the attitude of defence, and to snap fiercely at a stick presented to it the

instant it emerged from its shell. It is said that the sight of a kitten is perfected in a month, and that a chicken half hatched will catch a passing insect. Young partridges sally forth in search of food as soon as hatched, and are not unfrequently observed encumbered with portions of their shell. Generally speaking, land and water birds have their sight matured early, particularly those which are termed self-feeders; whereas in the perchers it is delayed for a much greater length of time; and, lastly, sight is remarkably early developed in insects. The moment the little bee emerges from the pupa it begins to construct a cell and collect honey and pollen.

In reviewing this very imperfect and disconnected sketch of the structure of the eyes of the different classes of animals, we cannot fail to recognise the fact that the human eye far transcends, both in mechanism and power, that of every other animal. Although remarkable in the early stages of life, this sense, by diligent culture, becomes exceedingly acute and perfect. To adopt the very significant words of Thomas Carlyle—"The eye sees what it brings the power to see;" which is so ex-

tremely well illustrated in the elegant and descriptive language of Dr. George Wilson, that we here venture to transcribe it. He says:—"The sailor on the look-out can see a ship where the landsman sees nothing; the Esquimaux can discover a white fox amidst the white snow; the American backwoodsman will fire a rifle-ball so as to strike a nut out of the mouth of a squirrel without hurting it; the Red Indian boys hold their hands up as marks to each other, certain that the unerring arrow will be shot between the spread-out fingers; the astronomer can see a star in the sky, where to others the blue expanse is unbroken; the shepherd can distinguish the face of every sheep in the flock; the mosaic-worker can detect distinctions of colour where others see none. The eye so triumphs over space, that it traverses in a moment the boundless ocean, which stretches beyond our atmosphere, and takes home to itself stars which are millions of miles away, and so far is it from being fatigued by its flight, that, as the wise king said, 'it is not satisfied with seeing.'" If, therefore, such manifold, surpassing, and inestimable advantages accrue from the culture of this precious gift,

how exceedingly great must be the loss if carelessly disregarded or neglected. In how many different forms does it unceasingly minister to our necessities, instruction, pleasure and happiness, and how many of life's varied and choicest blessings are received through the medium of sight alone, coming as they do from every part of the vast fields of animate and inanimate nature. While we contemplate with amazement and profound admiration its marvellous adaptation to our incessant wants, let us ever remember with reverence and gratitude that "the hearing ear and the seeing eye, the Lord hath made even both of them."

THE END.

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